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CHEMICAL & METALLURGICAL ENGINEERING

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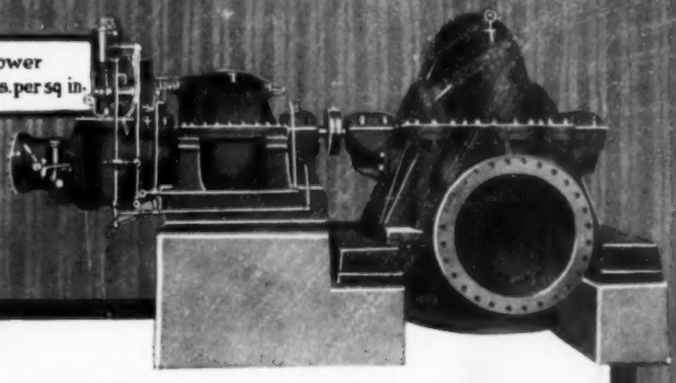

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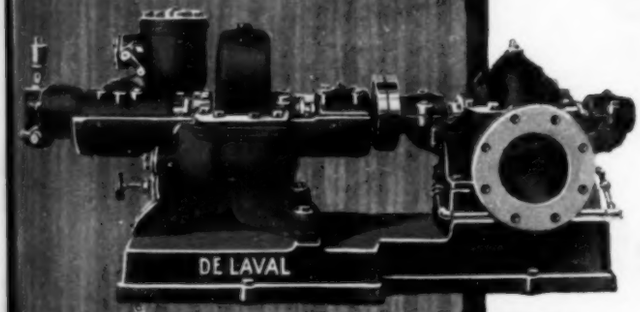

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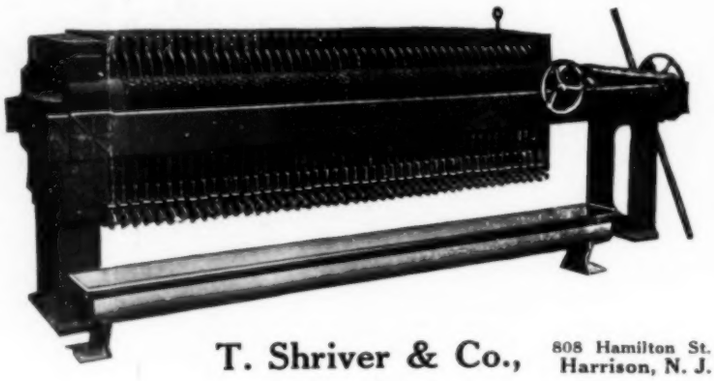

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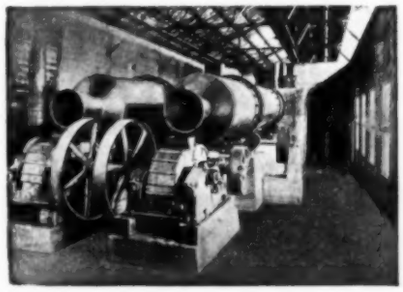

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Published December 24th, With Current News

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Out of The Woods

AS NOTED in our 11th issue, published December 8, but dated October 29-November 5, the problem before us at that time was to "catch up," and the best way out into the open then apparent was indicated. Since that date there have been printed, including the present issue, three double numbers in slightly more than two weeks, so that the present issue is mailed on the regular publication date. However, there still exists one issue not printed, which will be consolidated with the last number of the year, mailed one week hence. Thus it is that starting in with the New Year, CHEMICAL & METALLURGICAL ENGINEERING will be square with the world, and can buckle down to the long road ahead, to its function as a weekly technical journal advocating the best possible engineering practice in applied chemistry.

Every Engineer A Counter Propagandist

THE philosophic GOETHE lived in days when Germany was poor in pocket, but great in mind. And when, in "Faust," he desired to represent in *Mephistopheles* the spirit of evil, he made him the spirit that denied all things. He took the ecclesiastical devil and made him a devil of everyday life; for the spirit of evil of our day and generation is that which denies. Let us consider the subject for a minute or so.

The real trouble with labor just now is that in following KARL MARX it has come to the conclusion that labor is the true and sole source of all wealth, and that the representatives of capital are, in effect, the receivers of stolen goods; that they have got control of the machinery of laws and justice, and that the only way for labor to come into its own is to strike, and strike, until the administrators of capital are driven to cover, leaving capital behind them. Then labor will take this and enjoy its fruits. It may not sound reasonable, but such is the gospel.

Now if, in working for a man, a laborer believes his employer to be, in effect, a receiver of stolen goods, and therefore in criminal possession of his property, he cannot have faith in such a man, nor will he want to see him prosper. As a worker he will do as little as possible. If he belongs to the I. W. W., or is a Communist, or a Socialist of the radical wing, these are likely to be the views he holds. And the propaganda of these organizations, which he gets and the rest of us do not, teaches that government and courts are based upon an organization of capital; that they are founded on false premises, and should therefore be overthrown. The plan is to supplant the government by a "proletariat dictatorship" until a government of and by workers is established.

This is the doctrine that foments strikes, and resents profit-sharing, or any kind of internal organization of workers. The control of workers, it is held, should be from the outside, so as to destroy the minions of capital who are in control of industry.

Among many agitators this doctrine has become an *idée fixe*, and they can no more be argued out of it than a gamecock can be reasoned into leading a life of amity with his Plymouth Rock brethren in a barnyard. They don't want to be argued out of it, and they have a string of verbiage in reply to argument that would confuse a Philadelphia lawyer. Their business is rebellion; rebellion is their normal state, and if there were to be brought about the general strike which they are always trying to initiate, or the rebellion of the proletariat which they constantly urge should ensue, they would be quick to arise in opposition to it. They have no sense of system or of order, and whoever establishes system or order becomes their enemy thereby. This they constantly prove, even while denying it. Their policy is destructive, but never constructive. They hold the Russian Soviets to be a glorious success, and declare that those of us who do not agree with them have been misled by the false reports of a capitalistic press.

Not all our workingmen are built that way. Many are ambitious, and want to gain property for themselves; they want to own property, in time, and to be protected in their ownership. But we are neglecting our opportunity if we do not reason with them, and strive to keep their minds open while the apostles of anarchy are seeking with every persuasion at their command to close them. We must go out and do this thing ourselves, and we must put heart into this self-imposed task because men in revolt will not listen to paid pacifiers. We cannot trick them into assent, either, because trickery, like murder, will out. Then it breeds dissent. To accomplish this is difficult, and often disheartening, but it is the only way out. Industry requires eager and enthusiastic labor rather than cheap hands, and unless those of us engaged in industry become teachers of good citizenship by example as well as by precept, our industries are doomed. Neither invention nor astuteness can meet the deadening influence of denial and hate which thousands of agitators are preaching in nearly every industrial center, and which, if they succeed, will bring about such a reign of terror and confusion as to kill freedom—freedom for the individual man and woman. Not only will it put an end to legitimate personal opportunity, but it will utterly destroy free government.

Oil Shales and The Merchant Marine

THE United States Shipping Board now has control of a merchant marine of about 11,000,000 net tons —next to England's the largest in the world. This is the nucleus of a fleet of American-made and American-operated ships that may well re-establish our easily lost supremacy of the seas. Advent of coal-burning steamships, combined with England's vision in establishing coaling stations under the British flag throughout the world, was a potent cause of our downfall; the advent of oil-burning steamships and the vision of our Government in establishing fuel-oil stations throughout the world under the American flag will at least enable us to maintain our present maritime position. Coaling stations can be no more than 4000 miles apart, that distance being about the steaming radius for coal-burning ships, but an oil-burning vessel can steam 10,000 miles without refueling—and our established stations are within that distance apart. St. Thomas and the Azores in the Atlantic, Bizerta in the Mediterranean, the Philippines and Hawaii in the Pacific and Colon on the Isthmus assume added importance in this aspect of the situation.

If fully taken advantage of, the operation of an American Merchant Marine will be of incalculable value to the nation and should assure for our exports a freedom from foreign interference. All this provided the source of the fuel oil as well as the fueling stations be under the control of our Government to the extent of being located on American soil. Obviously, in time of danger it would be necessary for us to control absolutely the productive areas as well as the storage supplies and points of distribution.

The problem of supplying these fueling stations in the future is of considerable concern to those who are in position to understand the consequences should a serious shortage develop. Our petroleum fields have a limited length of life; it seems to be the consensus of opinion on the part of oil geologists that the probability of discovering further large oil fields within the boundaries of the United States is remote. We cannot be dependent upon oil from fields that are under the control of other nations in time of war, and for economic reasons it is not desirable in times of peace. By a process of elimination one arrives at the eventual resources of the nation—liquid fuel from solid carbonaceous material—peat, lignite, coal, bituminous sandstones and oil shales.

The Navy Department with commendable vision has had large tracts of oil-shale lands withdrawn from entry in order to establish a reserve for the future, and with this end in view is co-operating with the Bureau of Mines in the development of methods whereby the oil in this shale can be made available for use. The Southern Pacific Railway Company is also co-operating with the Bureau of Mines along these same lines, realizing the importance of a source of fuel-oil supply along its right-of-way independent of the California petroleum fields. It would also seem desirable that the Shipping Board investigate the feasibility of developing a supply of fuel from oil shales.

It will be necessary to conduct extensive and costly experiments before the technical problems connected with the distillation of oil from shale and the recovery of the by-products will be economically solved. It is certain that a profitable shale-oil development will require large capital expenditures, and successful installations must be able to handle large tonnages from deposits that are known to be of sufficient magnitude to assure a long life to the enterprise. Potentially the oil-shale deposits in our Western States are a national asset of first importance, but their development should proceed along rational lines and should be undertaken only by those thoroughly cognizant of the financial and technical magnitude of the problems involved in the establishment of an oil-shale industry. Wildcatters are ready, but enormous monetary loss can be avoided by some scientific agency approaching the problem with the wide technical view necessary for success.

Reconstruction Still Lags

IN A material way the greatest loss occasioned by the prosecution of the war was the curtailment in construction work. In normal times the world is continually building highways, railroads, factories, hotel and office structures, dwelling houses, power plants, and such things. The war greatly curtailed this activity, and thus there was a great halt in progress. Undoubtedly, taking the world as a whole, that loss was a greater amount than the loss by direct destruction.

During the year following the Armistice, however, such work has not only not been prosecuted with greater than normal vigor, but there has not been even the normal amount of such activity. The war, in other words, continues to retard progress. This loss has been world wide. It is not confined to the belligerent countries. Sir GEORGE PAISH was right when, in February, 1916, in an article in the New York *Sun*, he said: "The idea that the United States is deriving any advantage whatever from the war is a complete delusion. All that is happening to the advantage of your country is that it is suffering less than the belligerents as a result of this titanic conflict."

He was right. What appeared to be a gain during the period before the United States entered the war was simply that the other countries were losing more than we, and thus we came to occupy a better position, simply relative to them. For instance, we made shells for Great Britain, for which that country now owes us money, and eventually it will pay us interest at a low rate. If instead of making shells we had drained swamp lands or built hydro-electric plants, we would now have the improvements and they would be paying us much larger dividends than the interest from Great Britain will amount to when it is paid, for just now we are not even getting paid hard money for interest, we are actually engaged in funding the interest. When the United States entered the war the case was made so much the stronger.

It is true that the war added much to the knowledge of the world. It developed aviation, for instance, and gave the chemical industries, particularly in the United States, a great deal of information that they did not have prior to the war. Knowledge, however, is useless if not applied, and to apply most of the knowledge contributed by the war, construction is necessary. Construction is retarded by effects of the war, high prices, unwillingness of men to work hard, but possibly more than any other one thing, to the growing spirit of distrust and lack of confidence which is arming each man even against his friend and neighbor. Yet there are some bright sides to the situation.

Industry must stagnate when it has no improvements to make, when manufacturers have no ideas whereby they could embark in fresh ventures. There is an ample store of ideas. It is dangerous for too much construction work to be indulged in. A favorite theory as to industrial depressions is that they are caused by there having been too much construction work, too much capital having been converted from liquid to fixed form. Present conditions, as to costs and the unwillingness of men to work hard and efficiently, tend to discourage construction work, and while some is being done, enough to furnish all the work that men are willing to do, there is a great deal of work that is held in abeyance. This can be done in the future when men are willing to do it. One cannot possibly see at the present time any danger that construction work will be carried too far. In eight years after the Civil War we doubled our railroad mileage, building 35,000 miles, and then found we had built more railroad than we could patronize to a sufficient extent to make it pay well. Now we are not building railroad at all and are building scarcely any rolling stock.

We are, however, building tremendous numbers of automobiles and we must be making enormous numbers of silk shirts, judging by the stories in circulation as to the way workmen are buying them. This is not the conversion of liquid capital into fixed capital, to produce in some later year an industrial depression. It is converting money into something that is very far from being fixed. By many all of this extravagance is regarded as a bad thing, as doubtless it is, but for the long-range effects there are worse things. If it is wrong, the punishment will come quickly instead of being deferred, as it is when too much construction work is done. It is better probably for the war still to be retarding our progress than for it to leave a stimulus to cause us to make progress at a greater rate than we can safely stand over a period of years.

Books Beat Bullets

ABRAHAM LINCOLN'S homely philosophy endeared him to his contemporaries, and now has exalted his memory to that of an immortal purely because it matched his life and was based on careful thinking from a fundamentally sound set of principles. Therefore many of his sayings are independent of time and place—to the point then, they still apply to modern problems, and will be quoted for guidance again and again.

How aptly significant are the words: "Rattlesnakes and panthers and Indians know the fighting game and have weapons for the purpose, but this sort of fighting will never make the world a better place to live in. If the world ever gets to be the kind of a place you ask GOD for when you pray, 'Thy kingdom come,' it's coming by brains and hearts instead of claws and fangs. You can't shoot sense nor religion into a man any more than you can beat daylight into the cellar with a club. Take a candle in, and the thick darkness disappears; just so give the people knowledge and their ignorance and intolerance and other devilment will disappear. I haven't lived so powerful long yet, but I have lived long enough to make up my mind that for the good of all mankind, books beat guns."

Chemical and Physical Constants

RESOLUTIONS were adopted at the Savannah meeting of the American Institute of Chemical Engineers cordially supporting the committee of trustees organized to undertake the business arrangements for the great work of establishing, bringing together, editing and publishing these enormous compendia of fundamental data.

Their first step is to raise $200,000, and they are entitled to the earnest and hearty support of American chemical industry in the effort. These tables are a matter of everyday interest in the solution of technical problems. Let us cite an example of their practical value. A great shipment of fluid merchandise was about to be made in tank cars. The managing director was on the job, and he asked the man in charge how full he was making the tanks. "Filling 'em right up," said he. "Well, stop it," said the manager. "What is the cubical expansion of this material?" Nobody knew. "Look it up in Landolt and Börnstein." It was not given there. "Then make a determination in the physical laboratory." This was done, and found to be about ten times that of water. The whole shipment might have been lost by a warm wave if this constant, which is nowhere given in the literature of the subject, had not been determined.

It has been said in Germany many times that their scientific literature lost them the war. In so far as we encouraged the Germans to publish everything we needed in their own way, and in their own language, this is true. When the war came on there was no less than a scramble on behalf of the Army, Navy, Airplane, Medical, Shipbuilding and Explosive Departments and Commissions, the National Research Council, the Council of National Defense, etc., all wanting Landolt and Börnstein's Tabellen—and hardly enough to go around!

Now, the Landolt and Börnstein tables are inadequate and incomplete, and in many respects incorrect. They are the best there are that are published and available, but they are not good enough for the needs of intensive chemical research and industry. There's no use trying to introduce any pseudo-practicality by calling only for compendia that are "likely" to be needed. Who knows what constants he will need before he knows his problem? And they must be right. A guess or an "approximate conclusion" as to the melting point of tungsten, or silica, was good enough until tungsten came into use, or firebrick to be really studied, and then the record was found to be wrong!

The time has come, too, when the English language should be made a great medium of expression for chemistry. Many of our chemists coming along and here already do not speak or even read German. They are not of necessity ignorant for that reason. And again, in the Inter-Allied Council and the International Research Council, the United States has agreed to do this thing. It is not a problem for the Senate to wrangle over, there is no politics in it, and the pledge was given by our own duly accredited men of science. Let's go to it, and give these trustees the help they need. They are giving their time and energy without charge. They consist of HUGH K. MOORE of Berlin, N. H., chairman (from the Chemical Engineers); JULIUS STIEGLITZ of Chicago University (from the American Chemical Society), and EDWARD P. HYDE of Cleveland (from the American Physical Society).

Western Chemical and Metallurgical Field

Notes on Magnesite Refractories

THE continuation of domestic dead-burned magnesite as the source of supply of the raw material for the refractory magnesite industry in this country depends upon the clarification of prevalent ideas regarding quality, supply, and cost to the consumer per unit of finished product, contingent upon the use of this material. Few of the factors pertinent to the manufacture of brick of excellent quality are understood by all concerned; the situation has been and is being obscured by conflicting statements and propaganda.

Some consumers assert that brick made from domestic dead-burned magnesite are of an inferior quality; this is regrettably true of a large proportion of the brick manufactured in this country until recently. The unreliability of the brick, together with the high prices which obtained during the war, added materially to the cost of a finished product, decreased furnace efficiency and therefore reduced output. The manufacturers of the brick gave quality of the raw material as the cause. The users had to have the brick regardless of quality or cost. The producers of dead-burned magnesite delivered a dead-burned material which did not produce a brick of good quality when used under the same manufacturing conditions as was the Austrian dead-burned magnesite; both the producer of dead-burned magnesite and the brick manufacturer were more concerned with meeting demands for brick than with the idea of establishing the industry on a quality basis.

Quality the Important Factor

The question of supply is of less importance than that of quality; there were times of acute shortage during the war, but this condition did not obtain for long. Quite recently the situation again became acute. The producers of dead-burned magnesite had ceased operations, there being no demand for their product. The brick manufacturers had expected Austrian dead-burned magnesite to come in as return ballast in food ships; this supply did not materialize. Users of brick allowed their stocks to become depleted in expectation of lower prices. This combination of circumstances suddenly became apparent, and it was necessary for one of the western producers to re-establish operations, thereby relieving the situation. This answers the question of immediate supply. The reserves in sight are claimed by the U. S. Geological Survey to be ample for at least twenty years at the present rate of consumption.

Question of Manufacturing Technique

The production of a magnesite brick of excellent quality is as much a question of manufacturing technique as it is of raw materials. Brick produced from dead-burned Austrian magnesite was the result of twenty years development from this particular material, and the brick makers in this country had established their manufacturing methods around this one source of supply. When it became necessary to manufacture brick from dead-burned domestic magnesite, the unreliable and non-uniform brick produced were admittedly caused by the difference in raw material. The production of an inferior article continued until the producers of dead-burned magnesite had imitated as nearly as was possible the Austrian dead-burned product, producing a satisfactory material, which was accomplished by the addition of iron oxides to the ground magnesite before burning, and the manufacturers had modified their manufacturing methods by alterations suitable to the domestic dead-burned magnesite. The function of the impurities associated with the Austrian mineral were not thoroughly understood, but the addition of iron to the domestic minerals was found to improve quality. California deposits, from which the supply was first obtained, are of the amorphous variety of magnesite, the Austrian deposits are of the crystalline variety; this difference was also thought to be an additional cause for the unsatisfactory product. The development of the crystalline deposits in Washington occurred during 1917. By this time the functions of iron, silica and lime were better understood. Brick has been made, within the last year and a half, from these deposits as well as from the California deposits that are said to be in every way the equal of any produced from the Austrian.

Adaptability of American Magnesite

The crystalline or amorphous nature of the magnesite has no effect on the quality of the product resulting from the burning operation. Either variety is converted into amorphous magnesium oxide at the temperature required to liberate the carbon dioxide, or at about 800 deg. C. The refractory properties of the brick are due to the formation of the crystalline variety of magnesium oxide, which is the mineral periclase. The structural properties of the brick at furnace temperature are due to the size of the periclase crystals, to the completeness of crystallization, to the nature and amount of bonding material and to the nature and amount of other impurities such as iron, lime or silica, which may be associated with or added to the magnesite mineral.

The iron associated with the Austrian magnesite, as carbonate, and that added to domestic magnesite, as iron oxides, acts as a catalyzer in producing periclase, increasing the rate of formation and lowering the temperature necessary for complete crystallization. In order to produce a uniform product the iron and magnesia must be intimately associated. In the Austrian magnesite, this has been done by nature; with the domestic, fine grinding and intimate mixing are essential. Silica reacts with iron oxides to form silicates which are fluid at the temperature required to produce a dead-burned product, between 1450 and 1500 deg., and assist in the uniform distribution of the iron throughout the amorphous magnesia. Iron, silica and lime must not be present in amounts deleterious to the production of brick designed to have maximum strength at furnace temperatures. Silica, and iron combined with magnesia, act as a bonding material for the periclase crystals and the physical characteristics of brick can be controlled by the amount of silica and iron in the dead-burned magnesite used in their manufacture. Finally, press molding and correct kiln operation must be an adjunct to a satisfactory raw material if a superior brick is to be produced.

It appears to be a reasonable claim and an established fact that brick can be produced from domestic dead-burned magnesite, in which the amount of lime and silica has been controlled by selection and blending, that are equal or superior to any yet produced from the Austrian product. Looking into the future, the users of magnesite brick may demand and receive a superior article from the brick manufacturers, and therefore expect a reduction in the cost of this material per unit output.

New Jersey Chemical Society

A MOST interesting program was provided for the December meeting of the New Jersey Chemical Society, which was held at Stetter's Restaurant, Newark, on Monday evening, Dec. 8.

Manufacture of Paints and Varnishes

Dr. E. C. Holton, chief chemist of the Sherwin-Williams Co., commented briefly upon a series of motion-picture films showing some of the products made by this company. The manufacture of lead-zinc paints was illustrated in considerable detail, from the mining of the mixed sulphide ore through the concentrators and roasters to the mills which grind the pigment in oil, and the filling machines which deliver the product ready for shipment. Numerous views of the different plants of the company served to convey an idea of the magnitude of the organization.

The Lake Asphalt Industry

The paper on the lake asphalt industry, delivered in the absence of Mr. C. N. Forrest by Mr. J. S. Miller of the Barber Asphalt Co., proved to be the feature of the evening. Mr. Miller discussed the nature and occurrence of natural asphalt in the lakes of Trinidad and Venezuela. The importance of colloid chemistry in the study of bitumens led the speaker to a general discussion of the colloidal state of matter. Research has demonstrated that the difference in physical properties between natural asphalt and artificial asphalt (obtained as a residue in the distillation of asphaltic-base petroleums) is due to the presence, in the former, of colloidal particles of clay. Owing to their extremely small size, the surface energy of these particles is enormous. This accounts for the superior binding powers of the natural asphalt. Attempts to prepare similar colloidal suspensions of clay in artificial asphalt have not met with perfect success, although progress is being made in this direction.

It is interesting to note that the ultramicroscope proved invaluable in this research, since the particles are too small to be visible in the ordinary microscope. The supernatant liquid from solutions of natural asphalt in benzene which have been allowed to stand undisturbed for six months shows the Brownian movement of the colloidal particles when viewed under the ultramicroscope. Through unlimited perseverance, the research department was able to secure (for the first time) motion-pictures of the Brownian movement. The difficulties encountered in the preparation of this film are readily appreciated when it is considered that the particles to be photographed are smaller than the silver bromide grains in ordinary film. The remarkable results obtained brought forth hearty applause from the members and their guests.

Other films showed the mining of asphalt at the Venezuelan lakes, the necessity of re-mining from the steamer hold, and the making of asphalt roofing.

Filter Presses and Filtration

Mr. C. L. Bryden of the United Filters Corporation described the various types of filter presses placed on the market by this company, emphasizing his points on constructional detail by a series of lantern slides showing the Kelly and Sweetland pressure filters and the American continuous filters from many points of view and under various operating conditions.

Priestley's Home Purchased by Penn State Chemistry Alumni

THE original home and laboratory of Dr. Joseph Priestley, the famous chemist who discovered oxygen in 1774, which is located on the banks of the Susquehanna River at Northumberland, Pa., was purchased recently by graduate chemists of the Pennsylvania State College, who plan to move it to the campus and make it a lasting memorial to the great scientist.

Upon learning that the Priestley homestead, which was built in 1794-96, was to be put up at public auction, the Penn State chemists sent as their representative to the sale Dr. G. G. Pond, dean of the School of Natural Science at the College. He was successful in making the purchase, and thereby was able to announce that the old historic mansion would be preserved in its original lines.

Expert architects from the College will at once make the necessary surveys preparatory to the work of moving the Priestley home from Northumberland, Pa., to the campus at State College, a distance of about 60 miles. While the purchase of the home has been made by Dr. Pond for the Penn State chemistry alumni, who are scattered to all parts of the country, funds for its removal and erection on the College campus will be supplied by an as yet unnamed donor. Actual work of removal will probably be started in the spring. The reconstruction on the College campus will be along the old architectural lines, but modernized and adapted to some suitable use by the School of Natural Science, according to present plans.

Dr. Priestley's career as a scientist in the last half of the eighteenth century was one that has established him as one of the greatest in history. He is credited with the discovery of oxygen and many of its properties in his laboratory in England in 1774. About the same time he discovered ammonia and hydrochloric acid, and a year later, in 1775, he was credited with the discovery of sulphurous acid gas. Within another year he found nitrous oxide (laughing gas). His discovery of nitric oxide dates from 1772. A large amount of his experimental work was conducted after 1780 in Birmingham. He was a noted dissenter in religious views and was persecuted in England for his Unitarian teachings and activity. His house in Birmingham was mobbed and all of his chemical and physical apparatus destroyed. He was made uncomfortable in London, and, not being sure of his life, he came to America in 1794. His sons had preceded him. He settled at once at Northumberland and built the Priestley mansion there. He continued his experiments there until his death, in 1804. He was buried at Northumberland, and the house and grave have been visited by interested persons from all parts of the world.

In 1874 a large number of chemists gathered there to celebrate the 100th anniversary of the discovery of oxygen. These chemists formed the nucleus of what is now the American Chemical Society. One speaker on that occasion said: "Of the most important gases known at present, we owe nearly three-fourths to Priestley.

Dr. Priestley was a prolific writer, quite as much on religious as on scientific subjects. He was a vigorous and incisive teacher and preacher. His political principles found no favor with the Adams administra-

tion, and it is said that at one time he was threatened with expulsion from the country. However, he was a very ardent supporter of Jefferson, and was offered the position of Congressional chaplain, which he refused. His discoveries in chemistry would have established the fame of half a dozen ordinary workers, yet in his own opinion most of his results were accidental. One of the most important discoveries that he made at Northumberland was the fact that plants inhale oxygen in sunlight, and that oxygen turns dark venous blood red.

Beverage Exposition Features Chemical Equipment

THE Beverage Exposition and meetings of four associations held simultaneously in Chicago, Nov. 1 to 9, was an occasion of the largest gathering of the soft-drink industry representatives ever witnessed. The people engaged in this business have been very much in a quandary as to what the future holds, and this series of meetings was projected to help clarify the situation. This was the first show of its kind, and beyond all expositions that have previously been witnessed at the Coliseum was the most befitting combination of attractions for the general public on one hand and of deep interest to the industrial visitors on the other.

The industrial exhibits were the main feature of the exposition. In addition to the bottling machines, bottles and bottle washing machines, trucks, soft drinks, cereal

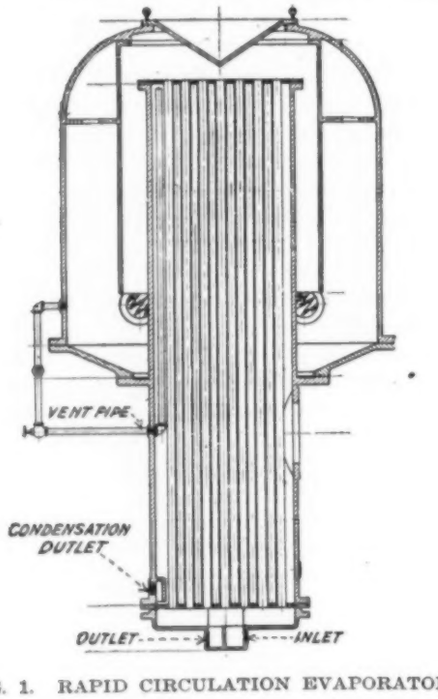


FIG. 1. RAPID CIRCULATION EVAPORATOR

beverages, soda fountain supplies and specialized equipment peculiar to the industry, there were many items of interest to the chemical business.

Evaporating and De-alcoholizing Apparatus

A special type of evaporator, known as the vertical rapid circulation evaporator, was shown by the Buffalo Foundry & Machine Co. Fig. 1 illustrates the apparatus in section. It employs the high velocity principle, thus keeping the tubes clean—an essential point in handling food products. It is particularly adaptable to the con-

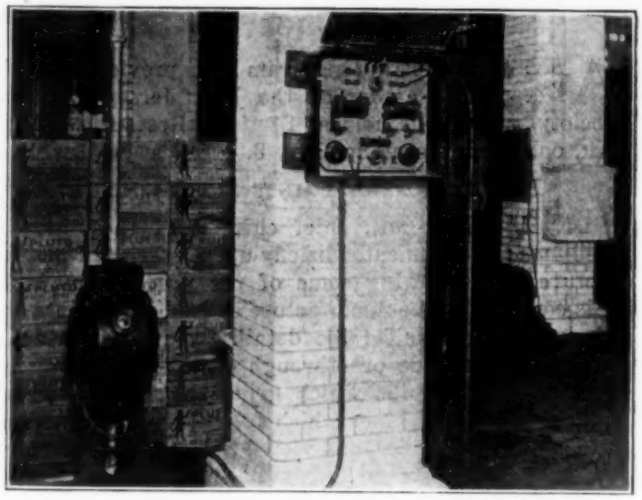


FIG. 2. STERILIZING PLUTO WATER BY ULTRA-VIOLET RAYS

centration of thin liquids of foamy nature, or organic solutions which should be exposed to heat for only a short length of time. This makes it suitable for malt extracts, fruit juices and de-alcoholizing beers and wines.

Vacuum evaporators for the removal of alcohol from fermented beverages without impairing the taste or character of the product were exhibited by the Hercules Engineering Corporation, and Joseph Schneible. The latter also showed sections of larger continuous stills capable of producing in one operation alcohol up to 192.5 proof, the residual beverage having zero alcohol content.

Filters

Since many beverages are susceptible to contamination or discoloration in contact with iron, filter presses having a cast iron shell and all brass, bronze or copper internal construction are used. A recent development of the United Filters Corporation is a special all-aluminum press, which is an item of value to the chemical industry generally, for the handling of corrosive liquids.

A demonstration was made of the manner in which Filter-Cel assists filtration of turbid liquids, by improving the clarity of filtrate, increasing capacity of equipment, decreasing labor of cleaning press, shortening the process and avoiding dilution in washing.

Glass-Lined Equipment

Glass-lined steel tanks and containers are extensively used for storing beverages and beverage syrups. The exhibits of Elyria and Pfaudler products were so arranged as to show the flawless character of the linings.

Recording and Controlling Instruments

The possibilities of automatic control of temperature, pressure, etc., in manufacturing processes were illustrated by an excellent line of "Tycos" and "Tag" specialties.

Sterilizers

Two methods of sterilizing were shown:

(*a*) By ultra-violet light. James B. Clow & Sons demonstrated a Type H-2, 1000-gal. per hr. ultra-violet-ray sterilizer, together with a small 120-gal. Type B-2. The number of these machines in commercial plants has demonstrated their efficiency for this class of work.

(*b*) By ozone. The Electric Water Sterilizer & Ozone Co., Scottdale, Pa., operated a sterilizer unit consisting

of ozone-producing and absorption apparatus mounted en bloc, capacity 550 gal. per hour, and an electric water sterilizer, operating on the electrolytic principle, capacity 1000 gal. per hour.

Bottling and Refrigerating Plants

Complete low-pressure bottling and refrigerating plants were displayed by the Liquid Carbonic Co. in a booth specially constructed in black and silver. The total effect was pleasing to the eye and the operation most instructive. The management was congratulated on every hand on its success in bringing together so scattered a trade as the beverage industry, thrown into exceptional confusion by the present novel conditions. The officers of the Beverage Exposition are: President and general manager, Felix Mendelsohn; secretary, Henry E. O. Heinemann; treasurer, P. M. Harwood. The headquarters are 1253 S. Michigan Ave., Chicago, Ill.

Chemical Warfare Service

TWO recent developments favoring the continuation of the Chemical Warfare Service as a separate unit have been the adoption of a resolution by the American Electrochemical Society and the appearance of Major General Sibert before the House Committee on Military Affairs.

At the October meeting of the board of directors of the American Electrochemical Society, President Bancroft submitted a report of the committee on resolutions regarding Chemical Warfare Service. The resolution, copies of which were forwarded to the members of Congress and the Army authorities concerned, is as follows:

American Electrochemical Society Resolutions

"Whereas the development of science and research is of paramount importance not only to the military establishment of the United States, but to the welfare and security of the entire nation; and

"Whereas the bill introduced into Congress for the reorganization of the Army (Senate 2715, 66th Congress) is not only clearly destructive of the Chemical Warfare Service, but is so drawn as to belittle all scientific and technical work in the Army and make it subordinate to the unscientifically trained officer; Therefore, be it

"Resolved, that the American Electrochemical Society urges strongly that any legislation for the reorganization of the Army shall provide for the continuing of the Chemical Warfare Service as a separate staff bureau as at present; shall provide for the commissioning of staff officers in the corps and departments in which they are to serve; and shall in general accord to the technical man full recognition and opportunity throughout every grade and department of the military establishment."

Gen. Sibert's Testimony

The appearance of Major General William L. Sibert, the director of the Chemical Warfare Service, before the Committee on Military Affairs of the House of Representatives, brought out little information that had not been presented earlier to the Senate committee, or has been set forth in the various published articles by General Sibert and other officers of the Chemical Warfare Service. In making his plea for an organization separate from the Engineer Corps, or the Ordnance Department, General Sibert pointed out the evils of having a unit too large for efficiency. Speaking of the Ordnance Department, he said that "when any branch of the service becomes so extensive in its various elements of work that no one man can keep sufficiently acquainted with the details of those various elements so as to direct them intelligently, it then is time to divide such an organization into smaller independent units." He pointed out that the chemical work of the Ordnance Department is not extensive, since the chemistry of powders is not a very big subject. The Ordnance, he said, is essentially a mechanical engineering department.

The chairman of the committee called General Sibert's attention to the statement by the Chief of Staff that it would be difficult to carry on experiments with gas around populous centers. General Sibert replied by citing the fact that experiments have been in progress for two or three years with all kinds of noxious and toxic gases at American University, which is practically in the City of Washington.

General Sibert testified that at present gas experiments are being conducted only in a very small way. This is due to the fact that equipment is now being moved from American University to the Edgewood Arsenal. In addition, the General Staff has not had an opportunity as yet to pass upon the program which General Sibert has proposed for field work. He stated, however, that the service is beginning to provide gas officers for the various infantry divisions. He took advantage of several opportunities to make clear to the committee the value to a nation of large chemical industries.

Imports Into Canada During the Past Two Years

Trade statistics as issued by the Canadian Government show that the imports into the country from the United States decreased from $752,810,282 for the 12 months ended July, 1918, to $695,268,163 for the year ended July, 1919. During the same time exports to the United States increased from $411,860,008 to $431,705,058.

Exports to Great Britain fell from $744,380,550 for the year ended July, 1918, to $546,866,571 for 1919; exports to France fell off from $150,597,165 to $80,945,701 during the same period.

The value of some of the principal articles imported into Canada for consumption during the past two years is shown in the following table:

Articles	Twelve Months Ended July 1918	1919
Articles for army and navy	$77,753,452	$27,573,380
Asphaltum and asphalt	361,950	385,380
Books and printed matter	6,645,730	8,704,152
Breadstuffs	20,436,388	21,488,310
Bricks, clay, and tiles	4,643,527	3,022,649
Chemicals	29,845,615	25,468,964
Coal:		
Anthracite	27,469,699	28,189,872
Bituminous	46,896,893	37,413,847
Cotton	64,795,347	65,192,086
Earthen and china ware	2,321,030	2,480,181
Flax, hemp, and jute	12,171,111	13,477,214
Furs	4,506,416	5,105,633
Hides and skins	7,069,342	7,936,129
Leather	10,493,774	11,163,097
Meats	13,263,400	16,488,031
Metals:		
Brass	5,074,550	4,657,851
Copper	6,290,813	6,028,100
Gold and silver	297,259	308,147
Iron and steel	156,322,603	151,172,247
Lead	1,288,813	626,386
Tin	14,570,566	11,975,234
Zinc	1,643,725	880,025
Paints, color, and varnish	3,341,986	3,262,580
Paper	7,542,037	8,813,815
Rubber	12,794,619	11,343,353
Soap	1,248,613	1,001,099
Stone, marble, and slate	1,987,642	2,265,614
Sugar and molasses	36,465,940	47,946,288

Cellulose Symposium

THERE was an interesting symposium on cellulose at the regular meeting of the New York Section of the American Chemical Society held at Rumford Hall in the Chemists' Club on Nov. 14. The first paper was by Mr. Wallace P. Cohoe, and had to do with "Present Day Problems in Regard to Cellulose."

There is a tradition, he said, that quick-growing plants do not make good paper, but this he declared to be erroneous. Bamboo and flax straw are excellent materials, and hemp and jute wastes are important for the purpose. Bagasse has not been profitable, so far, but in this respect it is possible that the final word has not been said. The uses of paper and pulp are constantly increasing, and new sources must be found. Among new uses he cited the nitration of wood pulp and artificial silk as important consumers. Rugs are made of mixtures of paper yarns with cotton and wool. The yarns made of paper fiber have slight holding power when wet and they must be heavily sized, which tends to make them heavy and stiff. Sisal and jute may be used for making paper, and good results are obtained from freshly handled manila waste. In Germany a great deal of paper cloth has been used for bed ticking. Paper burlaps are coming into use. The future of paper textiles, however, is not promising for human wearing materials. The art of the hydration of papermaking fiber has not yet been discovered.

Cellulose is at once perishable and permanent. Millions of tons are produced every year and turned back into the soil, and yet cloths from the tombs of the Ptolemys are still good and strong. We are still at sea in regard to the chemistry of cellulose.

Professor R. H. McKee of Columbia remarked in regard to paper materials that we had not yet adequately addressed ourselves to their proper culture. We use very little wild rice and no wild wheat, because the yield is so slight, nevertheless in reforestation we plant wild rather than hybrid trees.

Wild bamboo grows a foot a day, but our forest woods are usually of slow growth. New hybrids of trees have been developed that grow very fast. He spoke of a poplar hybrid that grew 27 ft. in 27 months, and a walnut hybrid that achieved remarkable growth, and yet the wood of these was no softer than that of the original stocks. He urged a greater encouragement of the study. If chemists lead in encouraging foresters to develop fast-growing trees to meet present and future needs, the woods are likely to be forthcoming.

Dr. Harold Hibbert made an earnest plea for a close study of the cellulose molecule, and he noted that more particularly the American chemical journals had been less diligent in this respect than their British and German contemporaries. The difference between monomolecular cellulose and sugar is one molecule of water, so that cellulose may be described as dehydrated sugar. Now, although the hydration of cellulose is not an accomplished fact, it certainly would be worth while to develop the art, and he believed that in view of the immense importance and scope of the cellulose industry, a Government institute should be founded to work on cellulose. He proposed an interesting hypothesis in regard to the structure of the cellulose molecule which may appear later in an original paper.

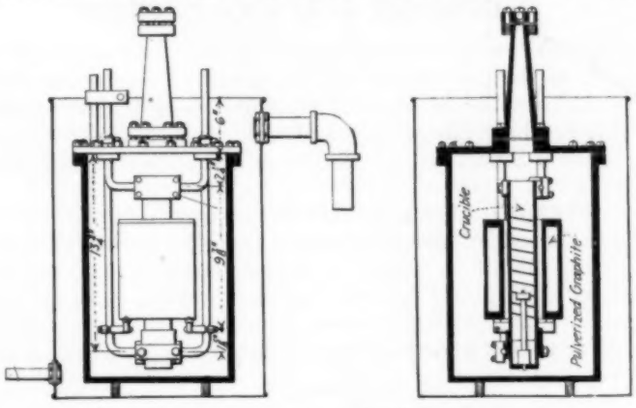
Dr. J. E. Miner presented a paper on her studies on cellulose hydration problems, and Messrs. Hamilton and Bradshaw gave their experience in the du Pont establishments with the nitration of wood pulp.

The Chicago Electrical Show

THE Electrical Show held in the Coliseum at Chicago Oct. 11-25, while in the main an exhibit of interest to the general public in its displays of household appliances and lighting fixtures, contained a few items of value to the chemical industries.

The Booth Electric Furnace Co. had a corner displaying some products of the furnace and photographs of the new designs. The Detroit Electric Furnace Co. showed a 500-lb. rocking furnace. Both the Edison Storage Battery Co. and the Electric Storage Battery Co. exhibited various sizes of storage batteries and accessories. The Elwell-Parker Electric Co., displayed two of the small industrial vehicles for use in warehouses and for indoor transportation throughout the factory. The Thomson Electric Co. advertised electric metal working machinery.

One display of particular note in ceramic work was contained in a glass case at the booth of the National



SMALL VERTICAL VACUUM FURNACE

Lamp Works. The ingredients for manufacturing the milk-white glass used in forming the new "White Mazda" incandescent lamp bulbs were contained in small crucibles adjacent to the finished product. They were labeled Litharge, Soda Ash, Feldspar, Fluorspar, Silica Sand and Niter. Relative quantities were not given.

A small laboratory type of electric vacuum furnace was exhibited by the General Electric Co. This is shown in the figure and contains a heating element of graphite wound as a helix within a steel vacuum chamber with lead gasketed joints.

A crucible of carbon, graphite, alumina, tungsten or other refractory required for the material to be treated is placed in a chamber within the helix. The temperature may be brought to any desired point up to 3100 deg. C. and the performance noted through a mica window in the top of the furnace. At 3100 deg. C. the power consumption is 15 kw. Maximum size of crucible which can be inserted is 1.5 in. in diameter and 4 in. high. This furnace may be adapted in the preparation of metals, alloys, carbides and silicides; in determining melting points of refractories, metals, etc.; in calibration of optical pyrometers; in distillation of refractory substances, and in study of equilibrium in reactions depending upon the pressure of the gaseous phase. Excellent quantitative results are said to be obtained with this device.

The Commonwealth Edison Co. displayed an electrical design over the door which outlined in lights the increase in cost curves of food, clothing and rents as compared with the decreasing cost of electric power.

Chemical Warfare Service Wants Recruits

Men with chemical and engineering experience are being called upon by the Secretary of War to enlist with the Chemical Warfare Service. It is the desire to obtain 1000 recruits at the earliest possible date. Enlistments are for 1 or 3 years. The men will be enlisted in the infantry, but assigned to the Chemical Warfare Service.

With the Chemical Warfare Service calling for recruits on the one hand, and asking assistance in placing some of its men in civilian positions on the other, it would seem that a conflict exists. As a matter of fact, however, there is no conflict, as the men being recruited are to serve as privates, while the men for whom positions are being sought are officers who desire to be relieved from service. Approximately 40 per cent of the officers remaining in the Chemical Warfare Service want to return to civilian employment as soon as a position that is sufficiently attractive opens. As practically all of the enlisted men in the Chemical Warfare Service had come in for an emergency only, they have been mustered out, and it is now necessary to build up a new enlisted personnel.

The Army Reorganization bill is taking form, with the probabilities pointing to the recognition of the Chemical Warfare Service as a distinct branch of the Army.

New York Section Meeting, American Chemical Society

At the December meeting of the New York Section, held on the evening of Friday, Dec. 5, in Rumford Hall, the following officers were elected for 1920: Chairman, Ralph H. McKee; vice-chairman, John E. Teeple; secretary-treasurer, Herbert G. Sidebottom; executive committee, D. W. Jayne, C. H. Herty, F. J. Metzger and K. G. Mackenzie. In addition, twenty councilors were chosen to represent the Section.

The technical program for the evening was opened by Dr. K. George Falk of the Harriman Research Laboratory, Roosevelt Hospital, who spoke on "New Methods of Food Dehydration." This method of dehydration, which consists in heating the food product at a relatively low temperature in a vacuum, was developed primarily for the purpose of preventing spoilage of meat during transportation in war time. Details of the process have been published in the *Journal of Industrial and Engineering Chemistry*.[1]

This paper precipitated a lively discussion in which Prof. S. C. Prescott of the Department of Agriculture took an active part. He has done a great deal of work on the air-blast dehydration process[2] and argued strongly in favor of this method.

The latest advance in this method is drying by means f moist warm air, which sounds paradoxical but is in ality most logical. The drying operation is started wth warm air containing a carefully regulated amount of moisture so that only a portion of the moisture in the food product can be taken up by the warm air. As the drying proceeds, the percentage of moisture in the incoming warm air is diminished progressively, until at the end dry air is used. The process is in effect an application of the counter-current principle. It is claimed that by this method the original flavor and palatability of the food are retained.

The program was concluded by a very interesting paper on "Emulsions," presented by Dr. A. W. Thomas.

[1] "Low Temperature-Vacuum Food Dehydration." K. George Falk, Edward M. Frankel and Ralph H. McKee, *J. Ind. Eng. Chem.*, Nov. 1, 1919, p. 1036.

[2] "The Work of the Harriman Research Laboratory, Roosevelt Hospital, New York City, in Affiliation With the Division of Food and Nutrition, Medical Department, U. S. Army." K. George Falk, *J. Ind. Eng. Chem.*, Nov. 1, 1919, p. 1062.

[3] "Relation of Dehydration to Agriculture," U. S. Department of Agriculture, Circular 126, Jan. 25, 1919.

Fixed-Nitrogen Corporation Proposed

Manufacture, production, and development of atmospheric nitrogen for military, agricultural, and other purposes is provided in a bill introduced simultaneously in the Senate and the House of Representatives. The bill was drafted in the War Department. It provides for the creation of the United States Fixed-Nitrogen Corporation. The stock in the corporation is to be owned exclusively by the Government. The bill empowers the Secretary of War to designate any five persons to act as an organization committee with authority to organize the corporation.

Among other things the corporation is to have the power to make contracts, appoint a board of directors, other officers and employees and to fix their salaries. The corporation may sue and be sued. It is to be conducted under the supervision of a board of directors consisting of not less than three nor more than 11 members, to be appointed by the Secretary of War. They are to hold office at the pleasure of the Secretary of War. The board of directors is to perform the duty usually appertaining to the board of directors of private corporations.

The corporation is to have the power to purchase, operate, and develop the nitrate fixation plants numbered 1 and 2, located respectively at Sheffield and Muscle Shoals, Alabama, together with the machinery, real estate, and laboratories pertaining thereto. This is to include the research laboratory at Washington, the Waco Limestone Quarry in Alabama, and the Electric Power Unit at the Warrior River Station of the Alabama Power Co.

After its completion the hydro-electric power plant now being constructed at Muscle Shoals is to be operated by the corporation. The corporation is also authorized to purchase, lease, or otherwise acquire United States or foreign patents and processes. It also may sell and export any of its surplus products not purchased by the United States or by persons within the United States.

The Question of Fuel Oil in France

A commission presided over by M. Henry Bérenger, Commissaire Général aux Essences et Combustibles, has been set up by the French Minister for Public Works to study the question of oil fuel in France. The following three decisions have already been arrived at: (1) The substitution of heavy-oil fuel for coal everywhere in the heavy industries and all public services is of the greatest possible urgency. (2) A progressive program is to be worked out for the adaptation of boilers and plants to burn oil fuel as from Nov. 15. (3) An organization is to be set up for at least five years for the national supply of heavy-oil fuels in co-ordination with the scheme for importing and producing coal. M. Bérenger and General Gassouin are to be in charge of the scheme in co-operation with the City of Paris and the Minister of Reconstruction.—*Iron and Coal Trades Review*, Nov. 21, 1919.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS

2, W. V. Davis. 4, Wallace Savage. 5, G. S. Patton. 6, F. W. Frerichs. 7, Mrs. May Helmley. 8, C. V. Snedeke. 9, Mrs. George S. Patton. 10, Mrs. F. W. Frerichs. 11, Augustus H. Fiske. 12, S. Felton Grove. 13, Mrs. Hugh K. Moore. 14, Wilbur L. Wright. 15, Mrs. Augustus H. Fiske. 16, Hugh K. Moore. 17, Mrs. Weir Gilmer. 19, Mrs. David Schwartz. 20, Alvin C. Goetz. 21, Frank N. Smalley. 22, Mrs. W. R. Clymer. 23, Clarke E. Davis. 24, Mrs. A. H. Hooker. 25, T. L. B. Lyster. 26, Miss Ottilie Prochazka. 27, A. H. Hooker. 28, Miss Hildegarde Frerichs. 29, L. G. Yankee. 30, William H. Gesell. 31, James Munn. 32, George A. Richter. 33, S. P. Miller, 34, Arthur E. Rice. 36, E. T. Marceau. 38, W. R. Clymer. 39, J. Bebie. 40, J. F. Wilkinson. 41, George D. Rosengarten. 42, F. I. Gibson. 43, A. Purcell. 44, Mrs. David Wesson. 45, Mrs. F. I. Gibson. 46, P. A. Heavitt. 47, David Wesson, Pres. 48, E. P. Poste. 49, Edward F. J. Puckhaber. 50, M. H. Gwynn. 51, Fred C. Zeisberg.

Chemistry and the South*

An Exposition of the Interrelation Between Fuel, Power, Cellulose and Mineral Wealth, With an Indication of the Future Advance in Southern Industry When Founded on Its Obvious Advantages

BY ARTHUR D. LITTLE

THE American Institute of Chemical Engineers is composed of men who are above all intensely practical, men who make it their life work to apply chemistry to useful ends. We have come to Savannah not merely to enjoy a proverbial and graciously extended hospitality, but chiefly because we recognize that here there is much for us to learn. Your cotton oil mills, your great fertilizer factories, the secrets of your naval stores industry, the doors of many plants distinctively Southern in their type have been generously opened to us. We shall take with us on our return new and enduring impressions of Southern courtesy and kindliness, convincing evidence of the magnitude of industrial achievement in the South, and a new appreciation of the wealth of resource and of opportunity in this supremely favored section of our country, but our mission will have failed unless we leave behind us a message so vital and direct in its importance that it secures and holds your attention and thereafter influences your action. And that message in a word is this: "The future of the South is in chemistry."

To insure acceptance any such general thesis properly requires demonstration. Suppose we begin by considering for a moment what the South already owes to chemistry.

The manufacture of fertilizers and the effective use of these artificial manures in the growing of crops are obviously based on chemistry and controlled by the laboratory findings of works chemists, the experiment stations, and the Bureau of Chemistry. The farmer, wiser than most purchasing agents, buys an analysis. Agricultural chemistry, with all that it means to the South, began in the laboratory of Liebig and gained recognition in this country chiefly through the writings and work of Johnson. The essential elements with which growing crops must be supplied are potash, ammonia, and phosphoric acid. It was the refined and classic work of the Dutch chemist Van't Hoff in physical chemistry which rendered possible the separation of the potash from the salts of the Stassfurt mines; the world has long derived its ammonia from the chemical processes of the gas works and by-product coke ovens; today it turns to the atmosphere for the larger supplies of ammonia and nitric acid which its growing needs demand and secures them by the chemical and electro-

*Presidential address (slightly abridged), American Institute of Chemical Engineers. Twelfth annual meeting, December, 1919, Savannah, Georgia.

PHOTOGRAPH TAKEN AT SAVANNAH, GEORGIA

52, John C. Olsen, Sect. 53, P. A. Heavitt. 54, B. R. Tunison. 55, Arthur D. Little. 56, W. H. Scott. 57, Elizabeth Ravenel. 58, Mrs. A. D. Little. 59, Alden K. Boor. 60, H. A. Edgecomb. 61, Mrs. Geo. A. Prochazka. 62, A. L. Christiansen. 63, George A. Prochazka. 64, A. E. Gibbs. 65, Frank T. Laird. 66, Herbert P. Strack. 67, Mrs. Fred C. Zeisberg. 68, J. T. Baker. 69, Mrs. J. H. Allen. 70, Mrs. Earle C. Pitman. 71, Brian S. Brown. 72, J. Henry Allen. 73, Mrs. B. R. Tunison. 74, Mrs. F. N. Smalley. 75, Mrs. V. H. Bassett. 76, Mrs. F. E. Dodge. 77, Leo M. Wachtell. 78, Mrs. R. F. Montsalvatge. 79, Mrs. John T. Baker. 80, Mrs. G. W. Thompson. 81, Gustave W. Thompson. 82, Frank E. Dodge. 83, George M. Davidson. 84, Mrs. G. M. Davidson. 85, Charles L. Reese. 86, W. H. Irwin. 87, Mrs. S. E. Seaman. 88, Philip Shuey. 89, Mrs. J. D. Bourne. 90, Richard K. Meade. 91 William R. Hulsizer. 92, J. E. Crane. 94, W. M. Whelpley. 95, Miss Lola Mae Vinson. 97, Albert W. Smith. 98, Mrs. A. W. Smith. 101, W. V. Davis.

chemical methods of nitrogen fixation, which, incidentally, have placed new values on Southern water powers. The nitrogenous fertilizer cyanamide is a direct descendant of calcium carbide, first produced commercially by Willson at Spray, North Carolina. The essential constituent of phosphate rock is rendered available by treatment of the rock with that basic chemical product sulphuric acid, while chemical processes have brought into use and service the low-grade ores contaminated with fluorine and alumina.

At the recent World's Cotton Conference in New Orleans it was stated that in growing cotton there was used on a one-horse twenty-seven acre farm selected as a type six and three-fourths tons of fertilizer worth $391.50 and one ton of nitrate of soda worth $90. The figures gain significance when we consider that the pre-war acreage, now somewhat reduced, was 37,000,000 acres.

Upon this vast expanse the South has annually raised for years an average of about 13,000,000 bales of cotton. The 1919 crop is estimated at 11,000,000 bales of staple worth about $150 a bale, with 5,000,000 tons of seed valued at $70 a ton—a total increment to Southern wealth of at least $2,000,000,000.

In no small proportion these values are due to chemistry. If they are attributed to the war we have only to reply that without chemistry the war could not have been fought at all, while in the absence of guncotton, which is merely cotton plus chemistry, it could only have been fought at great disadvantage to our allies and ourselves.

But we are happily now concerned with the peace-time uses of cotton. How far has chemistry extended them and put new values on the cotton crop? Cotton bleaching, which permits its use in fabrics of the finer sorts, is based primarily upon the discoveries of Schule, Weldon, LeBlanc, and Solvay, chemists all of them, and with the exception of the discoverer of chlorine, chemical engineers. Dyeing and printing, which so greatly promote the sale of cotton fabrics, involve pretty much the whole range of chemistry and are tied into its most modern developments, physical and colloid chemistry. The mercerizing process as ultimately developed by Thomas and Prevost imparts to cotton a wonderful silky luster and resulted in an enormous extension of its use in fabrics of the higher grades.

You will again be surprised to know that at least 2,000,000 spindles are to-day engaged in the business of converting cotton into automobile fabrics. There are 150,000 tires consumed daily. Within one or two years the tire production will have increased by 50 per cent, and spindles to the number of 1,000,000 more in this one industry will call to the South for new supplies of cotton.

CELLULOSE

Cotton in its purified form is the type of that wonderful substance cellulose, the structural basis of all plants and thereby the greatest structural material in all the world. The South has an interest in the chemistry of cellulose, for of it her forests are builded and on it her entire agriculture depends. The discovery of nitrocellulose by Schönbein in 1845 has resulted in an extraordinary concatenation of industrial, economic, and political consequences. From it came smokeless powder, the guncotton in the war heads of German torpedoes, the collodion of the surgeon, artificial silk, celluloid in countless shapes, substitutes for leather, the moving-picture films, the finish on brass beds, and the eyelets on our shoes. The South must credit Schönbein with the values placed on cotton linters and the shorter fibers adhering to the hull.

A more recent but analogous compound, cellulose

acetate, made by treating cotton with acetic anhydride and sulphuric acid, has already attained an importance only secondary to the nitrate in the arts of peace and war. In the form of cellulose acetate Southern cotton functioned high above the battlefields of Europe as the protective covering of airplane wings. To the same compound we are indebted for non-inflammable moving-picture films, for artificial silk of an altogether new order of merit, artificial bristles and horsehair, and for a substitute for celluloid wholly free from the dangers which always attend the manufacture and which sometimes accompany the use of this ubiquitous material.

But chemistry does not stop with the cotton fiber; it has enriched the South still further in the values it has put upon the cottonseed which once clogged Southern streams. Cottonseed today is worth $70 a ton because chemists have derived from this nuisance of pre-bellum days—it is hard to recall the Civil War, to which I now refer—edible oil, a solid substitute for lard, soap stock, a concentrated cattle feed, and residues of high fertilizing value.

Southern Bauxite and Sulphur

Southern bauxite, without chemistry, is merely a stone to throw at a dog. With chemistry, it controls the aluminum industry of the world. Louisiana sulphur lay secure beneath 500 ft. of quicksand until the chemical engineer Frasch brought it to the surface by methods so simple and so cheap that the groaning Carusi of Sicily were released from their intolerable burdens and set to work in sunshine on the soil whereunder they had toiled.

But why has sulphur any value in Sicily or Texas or Louisiana? Solely because the co-ordinated studies of generations of chemists have made it the foundation stone of modern chemical industry. As such it functions in sulphuric acid in countless reactions through the whole range of manufacture.

The largest sulphuric acid plant in the world is at Ducktown, Tennessee, but here the acid is made from smelter smoke and constitutes a striking example of a nuisance transformed by chemistry into a profit. Eight hundred tons of Southern sulphur are used each day in America alone, to an annual value of $7,000,000, because fifty years ago Tilghman, in Philadelphia, applied chemistry to the production of wood fiber for use in paper making.

Because Braconnot, in 1819, converted cellulose to fermentable sugars great plants are now operating in Louisiana and South Carolina converting the wood wastes from yellow pine lumber mills into ethyl alcohol. A Southern chemist, Charles H. Herty, held in honor and affection by chemists everywhere, has revolutionized your naval stores industry. Moreover, an actual $500,000 and a potential $1,000,000 at least has been added to the annual value of the turpentine crops by a simple change in chipping method based on studies made in France on the pathology of the wounded tree.

Other Natural Southern Products

Statistics often prove without convincing. They may compel the reason to assent without firing the imagination or arousing the will to action. I believe, however, that no one with the capacity to understand their true significance can review the colossal figures which set forth the natural resources of the South without first being stunned and overwhelmed and soon thereafter filled with the vision of their stupendous possibilities.

The South contains in superabundant measure the basic raw materials required for the development of great groups of co-ordinated industries founded upon chemistry and on a scale incomparably more vast than anything yet known. She has more than half the iron ore in the United States and 75 per cent of all the coking coal; great stores of lignite, natural gas, and oil. Here is the purest salt which occurs in nature, the cheapest and purest sulphur, clays endless in variety and extent, bauxite for aluminum and for abrasives, limestone adjacent to coal and iron, phosphate rock, gypsum, barytes, shale and quartz, ores of zinc and manganese, lead and nickel, titanium and tin. There is enough wood waste to supply the country's need for paper, and the world must soon look to the stumps on millions of acres of cut-over lands for its rosin and its turpentine. The cotton fiber is itself the raw material for many chemical industries of magnitude, and the short hull fiber, to utilize which in smokeless powder huge Southern plants were built, is now available for paper making and other arts of peace. The products and the potentialities of the cottonseed now have a rival in the humble peanut, and in at least one Southern locality the peanut crop exceeds the cotton crop in value. In the South as a whole the value of the corn crop already approximately equals that of cotton and affords a basis for great corn product industries. To such material resources, with many others, to which no reference can here be made, the South adds the potentialities of 5,000,000 hp. in the available energy of her streams.

Some Great Southern Plants

The South is no stranger to chemical developments on a great scale. The largest electrolytic copper plant in the world refines 720,000,000 lb. a year at Canton, Maryland; Ducktown, Tennessee, produces 1000 tons of sulphuric acid a day. The war called forth in Sheffield, Alabama, nitrate plants designed for a carbide production equal to that of the entire continent and for 100,000 tons of ammonium nitrate yearly. The Old Hickory plant at Nashville had an estimated cost of $90,000,000 and in nine powder lines, each of a capacity of 100,000 lb. a day, took the raw crude cotton and, producing both the acids and the solvents used, turned out the finished powder. The plant at Nitro, West Virginia, was designed for 625,000 lb. a day of powder. To the South must also be credited the great plant of the du Ponts at Hopewell.

These industrial achievements, stupendous though they are, derive their chief significance as evidence and measures of what will be accomplished in the South when capital joins hands with chemistry in the co-ordinated development of Southern resources.

J. W. Richards wisely and truly says, "The industries are fundamentally based on the imagination." Those who would share in this great development must mix imagination with statistics and have the courage to accept their findings and the initiative to act on them. What then may chemistry be reasonably expected to accomplish in the South? And how?

Southern Fertilizer Industry

With increasing density of population in the South and throughout the country a more intensive agriculture must everywhere be practiced. A great expansion of the Southern fertilizer industry, already so important, would seem to be assured. Improved methods of production will check the abnormal wastes which now accom-

pany the mining of phosphate rock, raise the intrinsic value of the product and permit of larger profits. The potash content of the gray iron ores of Alabama will be rendered available and supplied to agriculture as a by-product of the blast-furnace. From the expanding portland cement industry more by-product potash will be similarly derived. Ammonia from by-product coke ovens will be recovered in vastly greater quantities. Some extension of cyanamide production may be expected, but the vast stores of cheap nitrates and ammonia which the new agriculture will demand will come from the atmosphere by direct nitrogen fixation.

Southern Water Power Industry

Southern water powers will play an important although not necessarily a controlling part in their development. In the best interests of the South, it is in any case desirable that they be not linked up too exclusively to electrochemical processes, since these create relatively little opportunity for labor. It is incomparably more advantageous to constitute the water powers the centers of diversified and highly developed manufactures, the economic value of which may be a hundred times that of the water powers themselves.

It is probable, nevertheless, that for a generation or two at least Southern water powers are to find their chief applications in the field of electrochemistry, which is already extensive enough to insure a considerable diversity of industry. More and more will the electric furnace become a factor in the steel industry in the smelting of steel itself and in the production of ferro-alloys, of non-ferrous alloys, abrasives, carbide and other products now unknown. Methods of electrolysis will utilize much hydro-electric energy in making chlorine and alkali, chlorates, peroxides, perborates and persulphates.

The extraction of aluminum from bauxite is at last well established as a Southern industry at Maryville, Tennessee. In Alabama are great beds of bauxite only seventy miles from water power and with rich seams of coal between. But the production of aluminum is destined to be far more closely identified with the South. Ultimately will come effective and economical methods for the direct extraction of the metal from clay. Then each of the immense deposits of kaolin in Virginia, the Carolinas, Georgia, Florida and Alabama will be reconstituted as mines of aluminum ore.

Southern Clays and Fuels

The variety and range of character exhibited by Southern clays is amply sufficient to meet every requirement of the ceramic industries from bricks, tiles and terra cotta through pottery to porcelain. In many instances, the finer sorts have had their usefulness restricted by the presence of titanium minerals in small proportions. Here again chemistry has played its part by demonstrating a simple and inexpensive method for the removal of these impurities, with the result that the purified clays are suitable for the finest chinaware and porcelain. In the pegmatic dikes of the Appalachian region are great deposits of very pure quartz awaiting the enterprise of the glass maker.

Our present methods of utilizing coal are wasteful in the extreme. To set free its energy values we commonly employ means which wholly ignore its far greater chemical values. Moreover, bituminous coal, which constitutes the bulk of our supply, is not a desirable fuel for use in cities and our supply of anthracite is down to 190 tons per capita. Our railroads are breaking down under the strain already put upon them as transportation agencies and about one-third of their tonnage is coal. All this points to a radical readjustment of our use of coal and to a readjustment which should enormously benefit the South. It means that coal must be burned much nearer to the mine in super-power plants and its energy delivered to great common carrier transmission lines for power linked to hydro-electric developments and operated in co-ordination with them. It also means huge gas works in which the chemical values of the coal are saved as ammonia and tar, the coke converted into artificial anthracite and the gas made available for distribution for light, and heat and power over wide areas. There will follow as a consequence a corresponding development of the higher industries based upon the chemical values thus conserved, and producing dyes, intermediates, synthetic drugs and new types of coal-tar products. Lignite and peat will ultimately be involved in these comprehensive plans and yield their enormous quota of gas, ammonia and briquets.

Natural Gas and Oil

Natural gas, of which the South now yields 80 per cent of the country's whole supply, has not only been wasted shamelessly but was long regarded merely as a cheap and convenient fuel. We are now coming to realize that it has values and potentialities far beyond those of the thermal units it contains. Hundreds of plants now extract gasoline at the casing head, and the gas itself is recognized as a raw material available for many organic syntheses, as for example chloroform. Certain wells, notably those of Petrolia, Texas, have assumed an altogether new importance as sources of helium, urgently required for airships because of its high lifting power, non-inflammability, and low rate of dispersion through balloon fabrics.

Friction will bring the industries of the world to a standstill unless they are provided with a continuous and assured supply of lubricants, and these are practically all derived from petroleum. The impending exhaustion of the petroleum fields of the South is thus a matter of deep concern wherever wheels turn or machinery functions. The rapidly increasing and already extensive use of fuel oil is therefore an economic blunder which one day may be characterized as worse than a crime. Such oil as remains should be conserved until with incomparably greater benefit to the South due provision is made for utilizing its higher values in the production of lubricants, dyes and intermediates and the synthesis of gasoline by methods which Rittman, Cherry and other chemists have already indicated. It is important to remember that the asphaltic oils of the South are more reactive and therefore much more generally available for the higher syntheses than the oils of Pennsylvania, which have a paraffine base.

Southern Metallurgy

The wet methods of metallurgy as exemplified in the cyanide and chlorination processes have upset the economic balance of the world through the inordinate increase in gold production due to them. It may be regarded as certain that other wet methods will be developed, and it may easily be soon, which will render possible the profitable working of the great beds of low-grade ores of various metals existing in the South, as

for instance, the nickel ores of Georgia or the low-grade zinc ores of Missouri.

Iron and Steel Industry in the South

It needs no prophet to point out the inevitable vast extension in the South of the iron and steel industry already firmly established on a great scale. Around it will naturally evolve groups of associated and dependent manufactures—potash and slag cement; chemically pure iron and special alloys; plants for working up the by-products of the coke oven; new foundries and plate and wire mills and all the multitudinous activities based on steel and controlled by chemistry.

The basic chemical products, sulphuric acid, soda, bleaching powder and others known collectively as heavy chemicals, require for their manufacture sulphur, salt and limestone. Nowhere are these essentials available more profusely than in Louisiana, and the potentialities of their concurrence are magnified by their proximity to the great Caddo gas field, the oil of Texas and Louisiana and the cheap coal of Alabama.

Rosin and Turpentine

The world now depends chiefly upon the South for its supply of rosin and of turpentine, both relatively crude products and for the most part crudely used. Yet rosin is the cheapest organic acid available to chemistry and should be made to yield products of higher value and wider range of use. Turpentine is also the cheapest volatile oil and clearly indicated as the logical starting point for many syntheses. It is already the raw material for synthetic camphor, and camphor is worth $3 a pound.

The end of the virgin supply of crude turpentine is already in sight and much nearer than is generally realized. Fortunately for the South and for the world, chemistry has performed the double service of demonstrating that cut-over lands may profitably be cleared and new supplies of rosin, turpentine and pine oil extracted from the encumbering stumps of long-past lumbering. Even from the spent chips of the extraction plant, excellent Kraft paper has been made.

Bright Prospects for the South

In the future, the South must look for much of its prosperity to the utilization of present wastes. They are colossal in the lumber industry, in gas and oil and agriculture. A ton of straw, for example, will yield 11,000 ft. of gas or 800 lb. of high-grade paper. Great stores of ethyl alcohol, rosin, turpentine, gas and tar and many thousand tons of paper, container and building boards, fruit wrappers, bags and twine are potentially present in the wood waste burned in the South each day.

The high price of pulp wood has arrested the development of paper making in the North and for the next decade at least the expansion of the industry will be in the South, which offers the cheapest pulp wood on the continent outside of Alaska, and which offers also, in close association thereto, the raw materials required for its production.

To insure these benefits the South needs, as recently pointed out by Coates, the creation of an atmosphere in which the spirit of manufacturing enterprise may develop freely. It still lacks an adequate number of industrial leaders. It needs far more chemists and should place far more trust in those it has. It needs research and more research.

Plans for Manufactures Census Completed

SPECIAL effort is being put forth to make the manufacturers section of the approaching Fourteenth Decennial Census the most complete and comprehensive inventory of the nation's manufacturing establishments ever taken, according to officials of the United States Bureau of the Census who have this work in charge.

The schedules which will be used in tabulating the information about the country's industrial resources have already been prepared and printed. These schedules will be mailed to every manufacturing establishment in the United States during December, so that factory owners and managers shall be in a position to familiarize themselves in advance with the questions which are to be answered when the records of the past year's business have been compiled. The questions relate to the calendar year 1919.

Last Census in 1914

In 1914, the year the last manufactures census was taken, about 275,000 manufacturing establishments were listed by the Census Bureau. This time more than 300,000 establishments will be sent schedules. In addition to this it is expected that about 50,000 mines and quarries will also be reported.

The inquiries relating to manufactures, as specified by the act of Congress providing for the census, include the name and location of each manufacturing establishment; character of organization, whether individual, corporate or other form; character of business or kind of goods manufactured; amount of capital actually invested; number of proprietors, firm members, copartners and officers, together with the amount of their salaries; number of employees and amount of their wages; quantity and cost of materials used in each establishment; quantity and value of products; principal miscellaneous expenses; time in operation during the year; character and quality of power used; and character and number of machines employed.

The questions as outlined above will be covered by the general schedule which every establishment will receive. In addition to this a supplemental schedule will be sent to the 68 principal industries as classified by the Census Bureau. This supplement schedule, it is expected, will allow detailed statistics of output to be collected and set forth under the heading "products manufactured."

The census of manufactures is limited to manufacturing establishments with an annual product of at least $500 conducted under what is known as the factory system, exclusive of the so-called neighborhood, household and hand industries. However, no establishment is too small to be counted by the Government if it comes within the definition of a manufacturing establishment.

Information to Be Confidential

Census Bureau officials emphasize the fact that all information gathered by the census is strictly confidential, made so by act of Congress, and is for general statistical purposes only. The same is true of the censuses of population, agriculture, mines and quarries, oil and gas wells and forestry and forest products.

Many startling figures are expected to be shown by the approaching compilation, inasmuch as the industries of the country were for the most part in a subnormal condition in 1914, the year the last manufactures census was taken.

Pure Gum Shellac

Origin of Sticklac—Entomology of the Tachardia Lacca—Crops—Manufacture of Native and Machine Grades—Makers' Marks and Chemical Analyses—Specifications for Pure Shellac Varnishes Based on Experience With Impurities Encountered in Manufacturing Processes

By CHESTER H. JONES

THE continued and increasing use of shellac in the arts and industries and recent requirements for a pure neutral varnish to resist the action of various chemicals and electric pressures have awakened an interest in the circumstances surrounding the origin and method of production of the gum, with especial reference to the possible impurities which may enter into the processes employed in obtaining the commercial grades. Investigation has shown that a surprisingly large percentage of the better informed persons, and even chemists, who are familiar with this everyday substance as an ordinary varnish, have little or no knowledge of its origin and no information for use in distinguishing its value as compared with other varnishes. There is also little information available on the percentages, kinds and effects of impurities entering into the analysis of the different types or marks.

Many thousands of years ago in the mystic and interesting land of India it is recorded in the Sanskrit literature that the aboriginal tribes, seeking a coloring matter for their ornaments and clothing, found a resinous incrustation on the twigs of the Lakhsataru, or lac-tree, and by simple extraction in water secured a red dye known as lac-dye. This had been a standard article of commerce and chief competitor of cochineal up to the advent of synthetic dyes, but is now entirely discarded in the washing processes. The decrease in the use of the dye began in 1868 and was stopped entirely about 1900.

The value of the lac-resin as a varnish was discovered many centuries later, when probably its first use was the melting up and casting into beads, amulets and other native ornaments. The earliest record as an applied coating to woodwork was noted by Akbar in the Ain-i-Akbari in 1590. In 1596 a Dutch explorer describes its use in a European publication, but evidently was without knowledge of its origin.

Origin of Sticklac

The lac resin from which shellac is derived is made by an insect known as the Tachardia lacca, and its product, found as an incrustation on the smaller twigs of several types of tree, is broken off with the supporting twig, giving the sticklac of commerce. The specimen shown on the right-hand side of Fig. 1 is a branch of the dhak tree well covered with a fully developed incrustation.

The insects swarm twice each year, much as the bee, with about 5 per cent of the swarm consisting of males. Being gregariously inclined, they alight in densely packed masses on the twigs of the tree, as shown on the left hand figure in Fig. 1. An enlarged view of the top of the same twig is shown in Fig. 2.

As soon as the larva alights it buries its beak through the bark into the tender part of the tree, and inserting a sucking tube, proceeds to withdraw the sap. After absorption of some of the constituents of the sap and modification of others within the body, it excretes a fluid at the anal end. This excretion forms a covering over the insect and, slowly hardening on contact with the air, a cell is produced. As these cells are very close together, the whole coalesces and takes the form of a crust.

Entomology of the Tachardia Lacca

This insect being a most noteworthy little chemical factory in itself, and with habits and troubles which affect greatly the market quotations for its product, brief reference to the entomology should be of value.

The bug belongs to the order known as plant lice, or scale insects, whose habits are to suck the sap of plants with the proboscis, and to that particular group in the family which covers the body with an excretion. The original purpose of this performance was to protect from predacious enemies while attached to the plant.

The newly hatched insect is red or orange colored and very small. Fig. 3, right hand figure, shows first instar, active stage, magnified 40 times. Actual length of body is about $\frac{1}{40}$ in. At the end of the first month the female has built a cell around herself as shown in left-hand side of Fig. 3, and is about 1/18 in. in length.

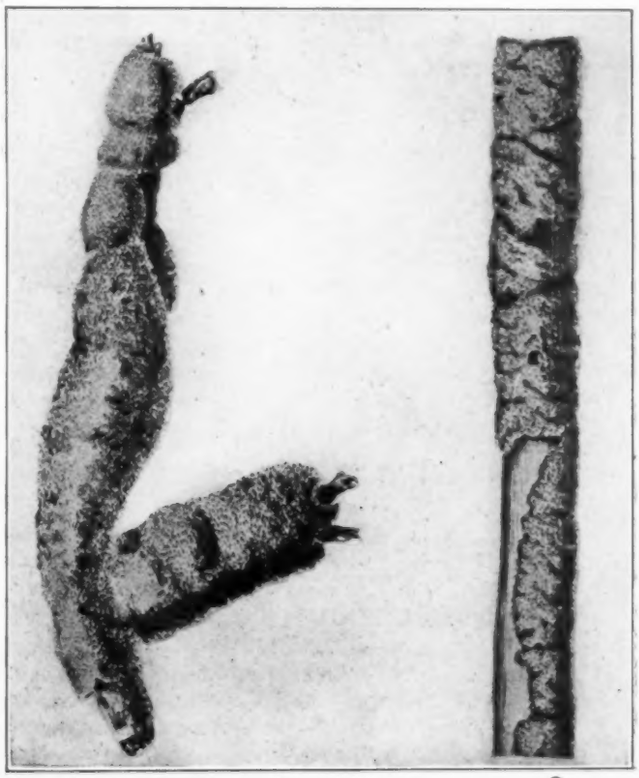


FIG. 1. SWARMING INSECTS AND STICKLAC

The body has turned dark red and the appendages have nearly disappeared.

When about two and one-half months old the female is impregnated by the male and continues to grow and exude lac for another two and one-half months. The ovary becomes so enlarged as to occupy nearly the whole body and is filled with a bright red fluid. This is the basis of the lac-dye. From this fluid the eggs form during the sixth month. The female has ceased feeding.

The lower right hand figure in Fig. 4 shows the female cell thirteen weeks after inoculation and the upper left hand figure shows the dead female cell with young emerging. This last, then, is a single cell nearly ready to harvest for sticklac.

The male insect after a short period of activity also comes to rest on a twig and forms a cell. There are two varieties of males as shown in Fig. 4. At the end of the sixth month the swarming shown in Figs. 1 and 2 occurs, and the crop is ready for the gathering.

Crops of Sticklac

India is the source of all shellac for the world markets, and the bulk of the sticklac is harvested there. Some of the latter, however, comes from the Malay Peninsula and Siam to Calcutta factories.

There are four crops gathered each year. The "Bysackie" crop is gathered in April in the Sind, Punjab, Bundelkand Bengal and Birbhum, reaching the factories in May and June. This is the principal crop of the year supplying the T N (truly native) grade.

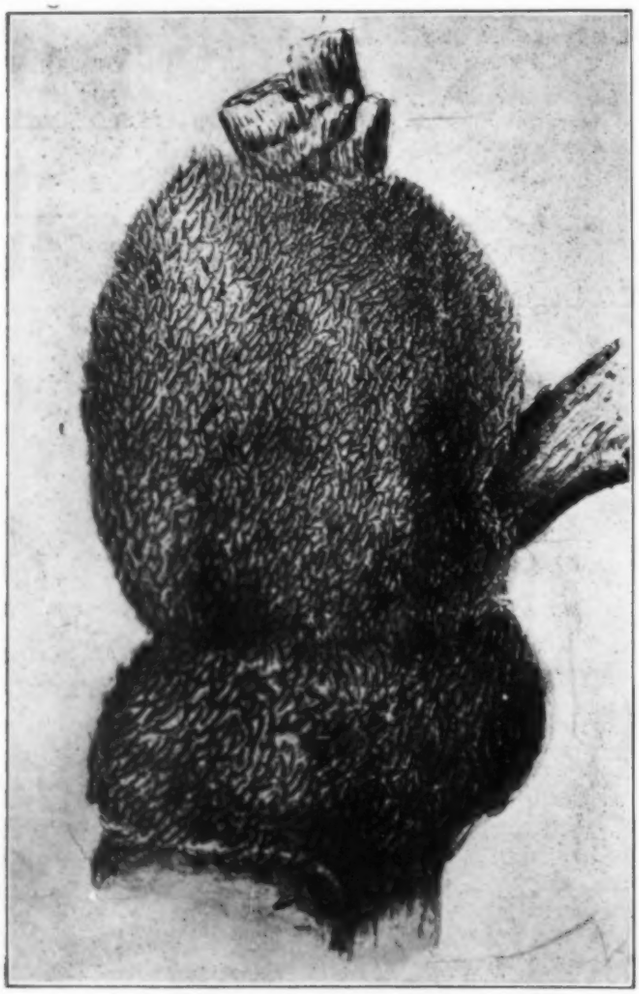


FIG. 2. SWARM OF TACHARDIA LACCA

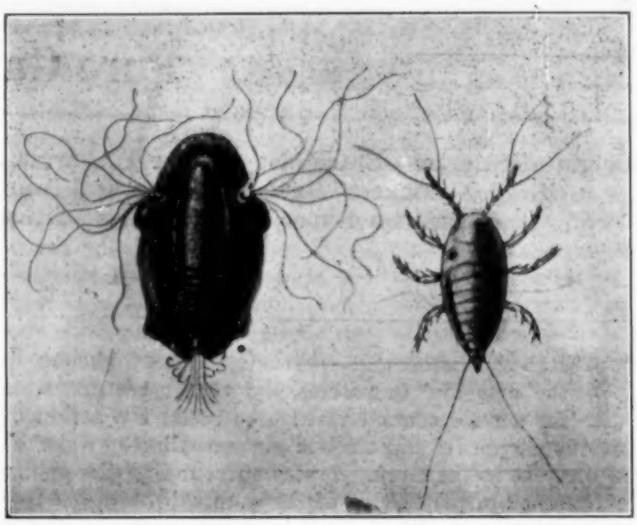


FIG. 3. RIGHT—FIRST INSTAR MAGNIFIED 40 TIMES. LEFT—FEMALE ONE MONTH AFTER INOCULATION, 25 TIMES ENLARGED

The "Jetowa" is gathered in August and September in Birbhum and Upper Burma. It is of fine quality and is used largely in seeding. The "Rungeen" crop is harvested in October and November in Sind, Punjab, Bundelkand Palamau, Birbhum, Assam and Upper Burma. There are said to be three crops per year in Burma.

The "Koosmi" crop, gathered in November and December, furnishes the finer grades. The quantities produced at each harvest in terms of finished shellac are approximately as follows:

	Lb.
Bysackie crop	50,000,000
Jetowa crop	1,300,000
Rungeen crop	3,600,000
Koosmi crop	11,500,000

Forestry

Each province or locality produces its own particular quality and kind of sticklac, which is determined very largely by the variety of tree on which the insect feeds. There are 88 varieties of lac-yielding trees, the most important of which are:

Butea frondosa (palas or dhak)
Cajanus indicus
Ficis bengalensis
Ficis religiosa
Ficis rumphii
Schleichera trijuga
Zizyphus jujuba

The preservation and cultivation of these trees to prevent entire destruction from the drain which they undergo during feeding of the lac insect and destruction of other agencies are carried on by the Indian Government. The Conservator of Forests, in charge of this work, also is responsible for keeping down the insects which prey upon the Tachardia lacca, and the promotion of the lac industry in general.

Manufacture and Refining

The raw material, consisting of sticklac and grainlac, is sold on the ground to middlemen who take it to the factories. Grainlac consists of incrustations broken from the twigs by wooden mallets, leaving the twigs on the trees. Fig. 6 shows the crop being harvested, dried and collected.

There are two methods of manufacture, namely, hand, or native, and machine method. The native process of

refining is much the same as has been employed in India for many centuries, and a large percentage of the market is supplied by native goods.

Native Manufacture

Upon arrival at the factory the sticklac or grainlac is ground in hand-operated mortars to remove from the sticks and to such a mesh as requires that the individual cells be broken open to free the remains of the inclosed insect. It is then sifted through a hand sieve. These operations are shown in Fig. 7. The products are here separated into three classes: (1) Granular lac, known by the trade name of seedlac; (2) fragments of branches and twigs, which are often used as fuel; and

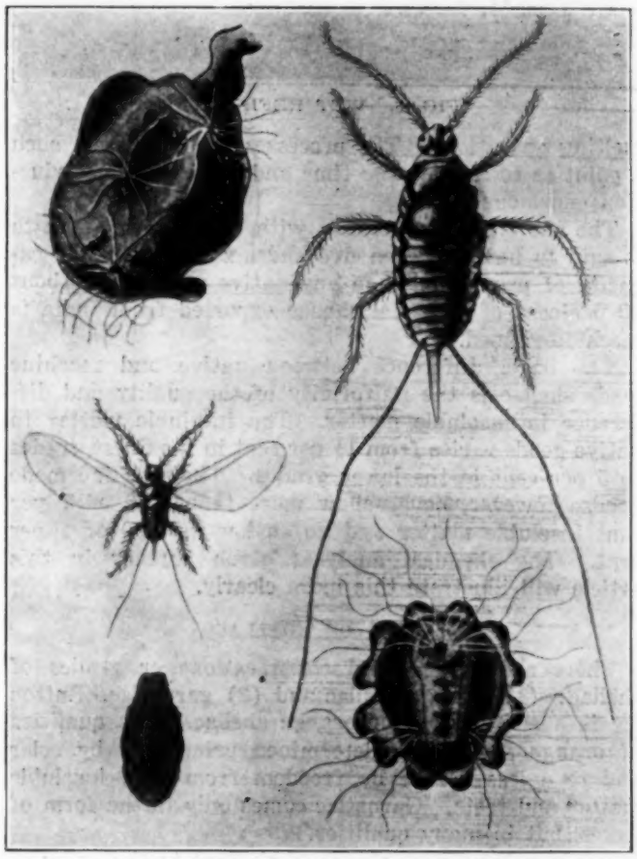


FIG. 4. FROM LEFT TO RIGHT—DEAD FEMALE CELL WITH YOUNG EMERGING, 4 TIMES ENLARGED. WINGLESS MALE, 12 TIMES ENLARGED. WINGED MALE, 40 TIMES ENLARGED. MALE CELL, 15 TIMES ENLARGED. FEMALE CELL 13 WEEKS AFTER INOCULATION, 15 TIMES ENLARGED

(3) fine dust, which consists of small fragments of lac and dirt known as Khud, which is sold to makers of trinkets and toys.

The seedlac is next washed, undergoing a soaking for about twenty-four hours, and is again ground to insure the breaking up of individual cells. It is desirable to wash out thoroughly the included organic matter. The wash water takes on a deep purple color due to the dye. A residue of dirt and fine lac is recovered from the wash water and sold to native bangle makers under the name of Gand. The washing process is shown in Fig. 8. After washing, the seedlac is exposed to light and air on drying floors, where it bleaches to some extent.

There are several variations of this method where lac is prepared for local consumption in the distant provinces away from the factories. In the Punjab the lac is boiled in a solution of crude sodium carbonate and borax, or rubbed in water with alum, and strained through a cloth, repeating until all the dye is removed.

In some cases, as in Hyderabad, the grainlac is mixed with potash, dry, and bleached in the sun. All the methods have the one object, that of removing the red dye.

Where adulterants are to be employed they enter the process at this point. Orpiment (As_2S_3) or rosin (im-

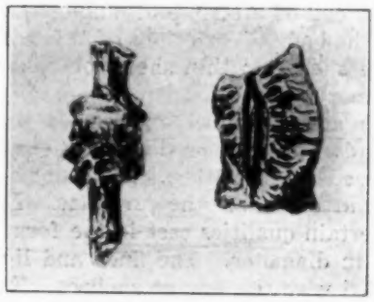


FIG. 5. LEFT—TRANSVERSE SECTION OF FEMALE LAC CELLS. RIGHT—LONGITUDINAL SECTION OF SAME

ported from North Carolina), or sometimes both, are mixed with the seedlac. The orpiment is used to impart a rich pale straw color to grades where a light color is required. The garnetlac and other darker grades will usually be free from this arsenic adulteration.

Rosin is added to lower the melting point of the seedlac so necessary in the next step of the process, and a certain amount is recognized as being necessary in the native operation. Rosin, however, in quantities, causes cracking and flaking in the final varnishes. The resiliency, or bending quality, is one of the valuable physical characteristics of pure shellac.

It is the practice of unscrupulous makers to add rosin in proportions as high as 20 per cent during high

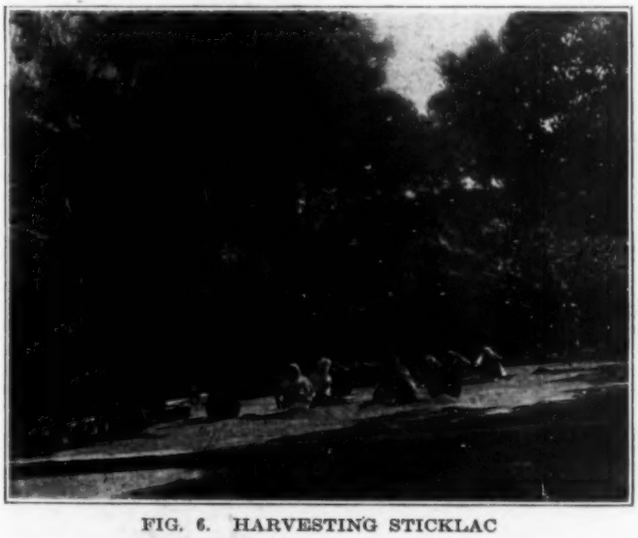


FIG. 6. HARVESTING STICKLAC

markets. Specifications should demand rosin content of less than 3 per cent for native commercial grades.

The mixture of seedlac and adulterant is placed in cloth bags about 12 ft. long and 2 in. in diameter. These bags are held before open furnaces heated by coke and charcoal fires, with a native at each end of a bag. Fig. 9 shows a view of the fireplace and Fig. 10 the melting and stretching operation.

As the contents of the bag begin to soften in the

portion directly before the fire, the bag is twisted, squeezing the melted material through the mesh. Occasionally a reverse twist is given to one end of the bag, causing an emptied portion to coil up. The bag is drawn steadily forward until all portions have been before the fire and the contents exhausted.

The melted lac drips to the floor. Any portions not sufficiently melted are recovered and remelted. The warm and partly molten lac is picked up by a third native, who stretches it into thin sheets by placing a foot on either end of a strip and pulling the center upward before the body. Variations of this action eventually bring the shellac to thin sheets or flakes, the form seen on the market.

The sheets are examined and sorted as shown in Fig. 11. All dark-colored or dirty portions are broken off and returned for remelting. Parts not bleached and of a red color are sorted as the garnetlac. Button lac is made from certain qualities cast in the form of buttons about 1½ in. in diameter. The finer and lighter qualities are graded with the orange shellacs. They contain the greater percentages of the adulterants.

After the bags are empty they are boiled to remove the residue, known as Kiri or Phog, from which inferior shellacs are made. These are cast in slabs about 6 in. in diameter and 1 in. thick and sold to makers of bangles, sealing wax and similar articles.

Machine Processes

The aboriginal method of manufacture has been much improved upon in recent years by the machine methods. These are employed by only one firm, as far as we know, however, and have not displaced the native methods of other makers because of the secrecy surrounding the design of machinery.

The sticklac and grainlac are fed to mechanical grinders, and steam enters largely into the washing and

FIG. 7. GRINDING AND SIEVING

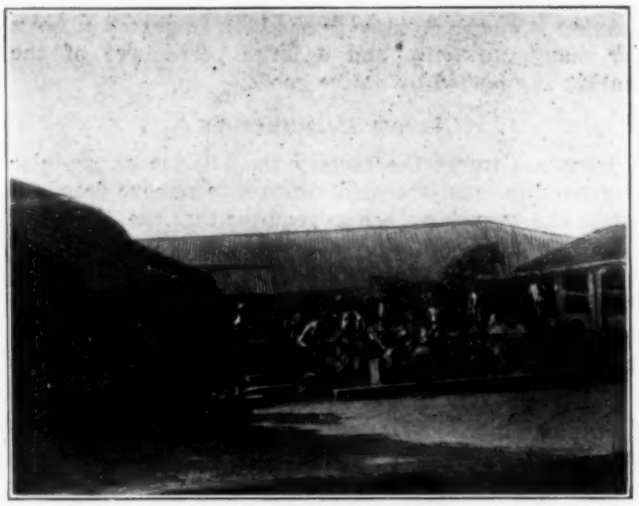


FIG. 8. WET REFINING

melting operations. The processes are refined to such a point as to shorten the time and increase the production enormously.

The one European concern with factories in Calcutta is said to have between five and six times greater capacity of production than any native producer. About 10 per cent of the total shellac exported from India is machine refined.

The basic difference between native and machine made shellac is the uniformity of the quality and difference in insoluble matter. The insoluble matter in native goods varies from 1½ per cent in the finest grades to 5 per cent in the lower grades. The machine made goods, however, never show more than 0.50 of 1 per cent insoluble matter and go as low as 0.20 of 1 per cent. The chemical analyses given further in this article will illustrate this more clearly.

Grades of Shellacs

There are two general classifications or grades of shellac: (1) Orange shellac and (2) garnetlac. Button lac is a sub-division of orange shellac. The qualities of orange shellac are determined principally by color and to a less degree by freedom from dirt, insoluble matter and rosin. Garnetlac comes only in the form of flakes, but in many qualities.

The popular native marks of shellacs in the order of their value and quality are as follows:

D C
V S O
Diamond I
Double Triangle G
Superior
Superfine
Fine
Good
T N (Truly Native)

These are all orange shellacs. The first four are called standard marks, each made by a separate native manufacturer.

The terms Superior, Superfine and Fine are simply descriptive, and in order named range from light to less light qualities down to T N, which is the lowest and darkest grade.

There are corresponding grades of machine-made shellacs. Of these grades, which are given under trade names of the maker,[1] the garnetlac is the superior grade where highest content of lac resin is required, regardless of lac, wax and color.

[1]Angelo Bros., Calcutta, India.

Chemical Analyses

Shellac consists of lac resin itself, which is the gum shellac; a certain amount of so-called lac wax, a hard whitish or brownish substance more like carnauba wax than any other; a small percentage of moisture and the insoluble matter, which is, speaking generally, either organic matter, the remains of the lac insects, and so-called residue of vegetable, mineral or other substances. Average analyses of high-grade native hand-made goods run about as follows:

	Per Cent
Lac resin	93 to 94
Lac wax	3 to 4½
Moisture	1½ to 2
Insoluble matter, of which the organic matter is usually two-thirds	1 to 2

Low-grade native hand-made shellacs analyze about as follows:

	Per Cent
Lac resin	91 to 93
Lac wax	3½ to 4½
Moisture	1¾ to 2¾
Insoluble matter, of which the organic matter is usually two-thirds	2½ to 4 or even 5

The average analyses of machine-made shellacs vary only slightly and run about as follows:

ORANGE SHELLAC

	Per Cent
Lac resin	95 to 96
Lac wax	3 to 4
Moisture	1½ to 1.6
Insoluble matter	0.2 to 0.3

GARNETLAC

	Per Cent
Lac resin	97.7
Lac wax	0.5
Moisture	1½ to 1.6
Insoluble matter	0.2 to 0.3

It is of course understood that the shellacs above mentioned are free from rosin. If rosin is added, cut down the percentage of lac resin in exact percentage to the amount of rosin.

The analyses of a large number of samples of crude lacs by Dr. D. Hooper for the Indian Forest Service have been averaged into the following table:

Name of Tree	Water	Resins	Coloring Matter	Residue	Ash
Kusum (Schleichera trijuga)	1.8	85.6	2.5	9.1	1.0
Ficus	1.8	83.9	2.6	10.2	1.5
Ber (Zizyphus jujuba)	2.0	82.7	2.4	11.5	1.3
Palas (Butea frondosa)	2.4	77.4	4.3	14.1	1.8

Chemical Composition of Shellac

Analysis of commercial D C shellac made by H. Endemann shows on treating with a caustic alkali solution a residual wax having a carbon content of 82.18 per cent and hydrogen 14.25 per cent. A complete analysis of the above gave the following:

4.5 per cent myricyl alcohol.
8.0 per cent non-condensable acids (not oxyacid) and impurities
27.0 per cent soluble and crystallizable oxyacid.
60.5 per cent oily oxyacid, only slightly soluble.

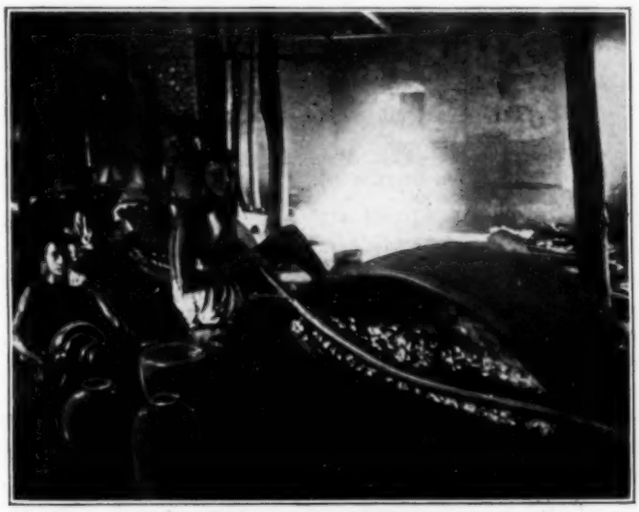


FIG. 9. FIREPLACE

FIG. 10. MELTING AND STRETCHING

Pure Shellac

Dry shellac for use in coatings in the United States Navy has been purchased for a long period of time on the following general specifications:

Orange Gum Shellac

Grade A Quality.—1. *For pattern and varnish work.* To be of a grade similar in quality to the brand known commercially as "Double Triangle G," and must be freeable by hand without the use of any tools. When treated with hot 95 per cent alcohol, the residue of insoluble matter must not exceed 1¾ per cent and the shellac must be free from rosin and other adulterants. All deliveries must be equal in color and in all other essential respects to the standard sample of this grade of shellac.

Grade B Quality.—2. *For coating linoleum-covered decks.* To be of good quality and must be freeable by hand without the use of any tools. When treated with 95 per cent hot alcohol, the residue of insoluble matter must not exceed 3 per cent. It must be of one of the following two qualities: (1) Free from rosin and have an iodine number of less than 18 as determined by method of subcommittee on shellac analysis (*Journal* of the American Chemical Society, pp. 1221 and 1227, Vol. 29, No. 8, August, 1907); or (2), the grade known commercially as "U. S. S. A. Standard T N," containing not more than 3 per cent rosin. The grade of shellac known as "New York Standard 3 per cent" will not be accepted. Deliveries of rosin-free shellac and "U. S. S. A. Standard T N" must in all essential respects be equal to their respective standard samples of these grades.

Grade C Quality—Garnetlac.—3. *Garnetlac for coating linoleum-covered decks.* To be of good quality and ground fine enough to be readily soluble in alcohol. When treated with 95 per cent hot alcohol the residue of insoluble matter must not exceed 1 per cent. To be free from rosin and have an iodine number of less than

18, as determined by method of subcommittee on shellac analysis, referred to above. All deliveries must be equal in all essential respects to the standard sample of this grade of shellac.

These specifications probably cover the situation where a coating of good mechanical and physical properties is desired.

Nearly Chemically Pure Shellac

If a covering is required where the shellac is to be subjected to electrical stresses or certain chemicals, and for special mechanical uses where flexibility is a feature, the specifications must be somewhat different.

During the period just past it became necessary to draw up specifications for shellac with which the interior of explosive shells might be coated to resist the action of new explosive chemicals on the steel body and to present a smooth tough surface which would cause little friction when the shell was whirling through the air, in case the cast charge became loosened in its container. In case of failure either the chemical action or the friction of charge against steel might cause premature explosion of the shell.

The first procedure was to send a number of samples of mixed varnish to the laboratory from a selection that had been passed on by commercial chemists as being satisfactory for the purpose. Results from two of these analyses were as follows:

SAMPLE MARKED "No. 1"

Acidity	Shows distinct acid test within a minute.
Ash	0.6 per cent. Contains manganese, zinc, iron, aluminum, calcium.
Flash point	Below 20 deg. C.
Action of picric acid	No action after 5 days' contact.
Time of drying	Fifteen minutes.
Covering quality	Covers well but dries too quickly for satisfactory brushing.
Hardness and adherence	Coating brittle, adherence poor. Does not pass the knife or hammer test.
Bending test	Cracks and flakes badly upon bending.

This sample does not comply with tentative specifications for interior shell coatings because of the poor adherence on steel, and presence of objectionable metals. Also on account of failure to pass acidity test.

SAMPLE MARKED "No. 3"

Acidity	Distinct acid test within one minute.
Ash	0.3 per cent. Contains zinc, calcium, aluminum, iron (trace).
Flash point	Below room temperature (70 deg. F.)
Action of picric acid	No action after 5 days' contact.
Time of drying	Ten to fifteen minutes.
Covering quality	Covers well, but dries too quickly for satisfactory brushing.
Hardness and adherence	Coating brittle, adherence poor. Does not pass knife or hammer test.
Bending test	Cracks and flakes badly.

This sample does not comply with tentative specifications for interior shell coatings, because of poor adherence on steel and presence of objectionable metals. Also on account of failure to pass acidity test.

The results of these tests show without doubt that the samples were of the usual mixed varnish type heavily loaded with rosin and of a poor grade of shellac.

Method of Testing

Shellac varnish analyses are rather difficult to run for impurities and chemical properties, so it was decided to test the ingredients for purity before mixing in the varnish and then try out for performance under as near service conditions as possible. The following procedure was followed with a number of samples with the purpose of ascertaining the reaction of various explosives upon shell protective coatings and the analysis of them to ascertain if they are true to name, and contain no undesirable metallic elements.

The explosives used were:

TNT
E L 104 (du Pont)
Nitro starch (du Pont)
Amatol (80-20) Picatinny Arsenal)
Amatol (50-50)
Sodatol (80-20)
Ammonal
Picric acid
Ammonium nitrate

Experimental shells were made by machining one-inch pipe caps until the inside was bright and smooth and then coating the interior with the lacquer to be

FIG. 11. INSPECTING SHELLAC

tested, some by brushing, and others by pouring in the lacquer, turning cap around to insure complete coating, and then inverting to permit the excess of lacquer to run out. (This gave a heavy coating.)

The caps were loaded reasonably full of the various explosives and put in an oven at 50 deg. C. for one week. At the end of the period they were unloaded and the condition of the film in the cap interiors was carefully noted. Results are shown with one sample as follows:

TNT—Film glossy, good condition.
E L 104—Film glossy, good condition.
Nitro starch—Film glossy, good condition.
Amatol, 80-20—Film glossy, good condition.
Amatol, 50-50—Film glossy, good condition.
Sodatal—Film glossy, good condition.
Ammonal—Film glossy, good condition.
Picric acid—Film glossy, good condition.
Ammonium nitrate—Film glossy, good condition.

Hot loading—thick film (poured):

TNT—Sweat out at upper edge of cup. Film unaffected.
Picric acid—The P.A. binds tightly to the lacquer. Film unaffected.

Final Specifications for Pure Shellac Varnish

After investigation and research extending over a period of several months a specification was prepared, and it is believed that use of the abstract of this, given below, will secure the purest shellac varnish commercially obtainable. Special applications must always be considered.

Varnish to be entirely free from alkali, mineral acids or volatile organic acids. Test to be made by thoroughly shaking approximately 20 grams of sample with 50 cc. of neutral distilled water, continuously for ten minutes. Then test with neutral litmus paper. If no change oc-

curs in three minutes the amount of acid or alkali is negligible. If either acid or alkaline reaction occurs the varnish will not be accepted.

Varnish to be entirely free from heavy metallic oxides for driers or any other purpose, except traces of iron oxide, lime or silica.

Varnish shall contain no nitrocellulose or any nitrated material.

Varnish must adhere firmly and when dry shall present a *heavy*, firm, tough, glossy coating which will not crack, peel or flake.

Varnish shall be mixed as follows:

Shellac	4 lb., 1 oz.
Alcohol	1 gal.
Turpentine	1/20 gal.

Shellac or garnetlac, used in the above formula, shall conform to the following specifications:

To be good quality and ground fine enough to be readily soluble in alcohol.

When treated with 95 per cent hot alcohol, or tested in an alcohol insoluble apparatus for shellac, the residue of insoluble matter shall not exceed 1.75 per cent.

Must be free from rosin and have an iodine number not more than 18, as determined by method of subcommittee on shellac analysis (*Journal* of the American Chemical Society, pp. 1221 and 1227, Vol. 29, No. 8, August, 1907).

Moisture must not exceed 1.75 per cent.

Ash must not exceed 1.5 per cent.

May be *any* color.

Alcohol, used in above formula, must be either 188 proof completely denatured or 190 proof specially denatured.

Turpentine, used in above formula, to conform to following specifications:

Quality—The turpentine shall be (1) either a properly prepared distillate from pine oleo-rosins, commonly known as gum turpentine or spirits of turpentine; or (2) that obtained from resinous wood by extraction with volatile solvents, by steam, or by destructive distillation, and commonly known as wood turpentine.

The turpentine shall be clear and free from suspended matter or water.

The color shall be water white.

The specific gravity shall not be less than 0.860 or more than 0.875 at 15.5 deg. C.

The initial boiling point shall not be less than 150 deg. C. or more than 160 deg. C.

Ninety (90) per cent of the turpentine shall distill below 170 deg. C.

The polymerization residue shall not exceed 2 per cent and its refractive index at 15.5 deg. C. shall not be less than 1.500.

Tests. Tests of ingredients shall be made by an inspector before mixing to form varnish, and the mixing of approved materials shall be witnessed by the inspector. The finished product shall then be tested for proof under the first part of this specification.

Shellac Markets

The shellac market is highly speculative, due to the wide variety of factors which have been seen to enter into the production. During recent months a great scarcity has caused the price to rise above a dollar a pound. Before spring, however, the importers predict, the best grades may be obtained at fifty cents per pound.

A free market condition is said to be desired by all, and for this reason the shipping season commences in early November and ends in May. With June the rainy season and the combination of moisture and intense heat endanger this free condition. From June to September, therefore, only lower grades are exported. The bulk of the shellac comes from Calcutta via Indian Ocean, Red Sea, Suez Canal, Mediterranean Sea to European and U. S. Atlantic ports. A portion goes to China and Japan to be shipped to American Pacific ports.

Industrial Uses

This substance has a very wide application in both the dry and varnish forms. As a molded product it is used in buttons, phonograph records, emery wheels, toilet articles, insulations, mica products, oilcloths, linoleums, sealing wax, hats, fireworks, paper, etc. As a varnish its applications are too numerous and well known to require mention.

Each particular requirement must be met by a thorough analysis of the conditions surrounding its use. Where purely ornamental purposes are to be served it is economical to employ the cheaper grades. Here color is usually the determining quality. When the chemical purity and mechanical strength are involved and the color is not material, the garnetlac grades are found to serve best.

We especially appreciate the assistance of Mr. D. W. Mulford in the preparation of this article.

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Mineral Leasing Bill

The general mineral leasing bill again is in conference, with bright prospects for an early agreement. This measure, which has a direct effect on 700,000,000 acres of public land and directly involves 6,500,000 acres of possible oil land, 70,000,000 acres of coal lands, 2,700,000 acres of phosphate land and 3,500,000 acres of oil shale land, has been under consideration in Congress for seven years. This is the fourth time the leasing bill has been passed by the House.

The House refused to allow the embodiment into this bill of the section of the Senate bill which would modify the decree of dissolution against the Standard Oil Co. of New Jersey. It also refused to embody in this bill the section of the Senate bill which provides that corporations engaged in producing or refining petroleum shall maintain the same price for their products where the stockholders of any one of such corporations own or control 25 per cent or more of the stock of any other of such corporations.

The House committee recommended that the fund accruing from leases should be divided as follows: 45 per cent to the Reclamation Fund, 45 per cent for the State and 10 per cent for the Federal Government. This was changed on the floor of the House, however, so that 70 per cent of the fund from past production would go to the Reclamation Fund, 20 per cent to the State, and 10 per cent to the Government. For future production 60 per cent is to go to the Reclamation Fund, 30 per cent to the State, and 10 per cent to the Government.

A provision in the House bill reserves helium production for the Government. While objection was made to this provision as being over-protection, it was allowed to stand mainly on the advice of the War Department that helium could be extracted from natural gas without interfering with oil or gas operations.

Development of American Research*

By Vladimir Karapetoff

FAR be it from me to urge greater emphasis upon research in our universities simply for reasons of national safety or because of advantages in competitive foreign trade. I shall not even urge it because of its evident importance in medicine, agriculture, engineering or government. No, I believe that our enlightened public opinion should rise to a point where it will demand recognition and support of investigators in pure mathematics, in theoretical physics and chemistry, in the study of nature and man, in philosophy, languages and literature, in fact, in any branch of human activity, no matter how remote a subject of investigation may be from our bread-and-butter problems. If we are to profit permanently by research—I am almost tempted to say if we are to become like older civilized nations in this respect—we must give up "practical" and mercenary ideas on research, and promote research for its own sake. It is like unto the Biblical precept that we must give up the ordinary sense of life in order to find the higher sense of life.

Pure Research Should Thrive in Universities

There are many good reasons for which pure research should thrive in universities; in fact, great universities in Europe are considered natural centers of higher learning and investigation. This function of the universities is not always clearly understood in this country even by persons upon whom their administration and support are dependent. A teacher in elementary subjects need not necessarily be an original investigator or deep scholar. If he is a "big brother" to his students, he can introduce them successfully into the intricacies of elementary chemistry or French 1 and leave a beneficial lasting impression upon their forming characters. But a professor of an advanced subject must be at least a fairly deep scholar if not an original investigator of first magnitude. Only then can he enthuse his students and open before them wider vistas, that inspire both for knowledge and for action. It used to be an education in itself to sit at the feet of Lord Kelvin or Von Helmholtz.

Men of High Caliber Lost to the World

The situation is this: Men of such high caliber sometimes do not find their real power until later in their lives. In the meanwhile the lure of the industrial world, of consulting practice, or text-book writing, too much elementary teaching, lack of literary work, lack of laboratory or library facilities, scarcity of research assistants, no appreciation, no place to publish the results of their research, financial worry, and lack of opportunities to travel and to meet fellow workers in other institutions or at conventions—all these factors dull their brilliant powers and bring an irreparable loss to the whole world. These men have no unions, no spokesmen, no influential organs of their own; they valiantly fight their battles each for himself, and they die at their posts meek, faithful and unheard of.

We hear too much about lack of university buildings, and an impression is sometimes unconsciously conveyed that the principal problem is to get more buildings. But I say that much brilliant pioneer work by men like Bunsen or Faraday has been done with most meager possible facilities. A good laboratory tends to encourage purely experimental research at the expense of analytical thinking and deeper interpretation. Curves, tables, experimental data of all kinds, are being published in an alarming quantity by mediocre men who have easy access to laboratory facilities. What we need in this country is more scientific men of prophetic vision, interpreters of the world, men of superior analytic and synthetic power who need no marble halls for their creative output; but such men grow only on a fertile soil, with a background of research and appreciation of culture behind them. These superior men step out of the background of a large number of less-gifted investigators and they lean upon those left behind for data, for companionship and for appreciation and approval.

As far as the higher form of university life is concerned, that is, research, what we need the most in this country is the correct attitude. Money, facilities and results will come in due time. This correct attitude may be summarized as follows:

Correct Attitude Summarized

1. Consider all scientific research, no matter how theoretical and remote from practical ends, to be a necessary and important factor in the life of a civilized country and the mainspring of its healthy progress.

2. Research has to be multiplied a hundredfold in all its forms, as is the case in Germany, so that every young American investigator could easily find his place and problem, and would not feel like the sole survivor of a sunken bark.

3. Do not expect immediate tangible results from a newly established research center any more than you expect them from a recently planted orchard. Take good care of it and it will bear abundant fruit in due time and for many years to come.

4. Provide living salaries for younger teachers in universities, in order to be reasonably sure of securing a large number of promising young men, who later may develop into research stars of different magnitude.

5. Do not lay undue emphasis upon experimental facilities and investigations. This country is markedly deficient in high-grade analytical thinkers, capable of sublime generalizations in science. No effort should be spared in seeking out and developing such men, and placing them under working conditions under which they can give to the world their best.

*Part of an address to the Cornell Alumni Association of Cleveland on "Significance of Research in American Universities."

Registration of Engineers in Iowa

It should be generally known that a law was passed by the last General Assembly of the State of Iowa requiring registration of all professional engineers and land surveyors and providing in Section 10 for their registration by Jan. 4, 1920, upon their professional qualification without examination. From Jan. 4 to July 4, 1920, registrations will require a technical examination before the Board. After July 4, 1920, practice in the State of Iowa without a registration certificate will be a punishable offense. The penalty imposed for such offense will be a fine of not less than $100 or more than $500. Application for registration, copy of law and instructions, from K. C. Kastberg, secretary Iowa State Board of Engineering Examiners, Box 923, Des Moines, Iowa. Other members of the Board are Seth Dean, L. M. Martin, F. W. Stubbs, and Alvin Le Van.

Potash Recovery From Blast-Furnace Gases in England

A Description of Potash Recovery as Carried Out in Connection With English Blast-Furnace Operations, Together With Notes on the Activities of the Potash Production Bureau in Cement Dust and Other Fields

By HAROLD HIBBERT

SOON after the outbreak of the European war in 1914, the British Government found itself in a precarious position in so far as the available supplies of potash were concerned, since up to that time the greater part of these had been obtained from Germany. As is well known, this product is used in connection with fertilizers and explosives, and also forms one of the basic raw materials for the manufacture of glassware. As the war progressed, the home manufacture of special optical glass for various scientific instruments, such as field glasses, microscopes, lenses, prisms, etc., became a matter of prime importance, hence a domestic supply of potash became imperative. Prior to 1913, the pre-war requirements of potash (potassium chloride) in the various countries were estimated[1] to be roughly as follows:

	Tons
United Kingdom of Great Britain and Ireland	35,000
United States and Canada	300,000
France	50,000
Italy	50,000
Germany	600,000

Thus it became necessary to devise some means of finding new sources of this material. The British Government created a special government department known as the Potash Production Bureau, which was attached to the Ministry of Munitions, the function of which was to stimulate potash production.

Of the various schemes submitted to the Bureau, the one which appeared to offer the most promising prospects for quick development and production was that in connection with the recovery of potash from the dust carried over in blast-furnace gases. Experiments carried out prior to 1914 at the plant of the North Lincolnshire Iron Co. served to indicate that this dust contained considerable quantities of potash salts, and as a result of the data submitted a company was formed, known as the British Potash Co., Ltd., with a capital of £100,000, of which the British Government supplied £50,000, thus becoming the owner of one-half the stock. The remainder was subscribed for by the British Cyanide Co. either directly or indirectly through their friends, especially those connected with the North Lincolnshire Iron Co., at whose plant the first large-scale experiments were performed. Considerable experimentation and research work have since been carried out both in the laboratory of the British Cyanide Co. and in connection with the various blast-furnace installations. It was decided by the British Potash Co., Ltd., that the most rational policy to adopt would be to have one central collection depot to which the potash dust from the various blast-furnace plants could be shipped for the extraction of the potash content, and in furtherance of this idea, a plant was erected at Oldbury on land adjoining that owned by the British Cyanide Co., where all the recovered blast-furnace potash dust is now being "treated."

[1] *Chemical Age*, July 19, 1919. This does not take into account the salts, such as the sulphate, etc.

Technique Employed in the Recovery of Potash Dust From Blast-Furnace Gases

The principal incentive to the earlier study of the removal of potash dust from the blast-furnace gases was not primarily the recovery of potash, but the great economic advantage to be obtained in the saving of fuel effected by using such "cleaned" gases in connection with pre-heaters, economizers, steam boilers, etc. Thus it has been shown in actual practice that using a cleaned gas—namely, one from which the dust has been removed—the stove surface area for pre-heating the air-blast can be reduced in the ratio of 3 : 5 as compared with gas from which the dust has not been removed. Furthermore, in the utilization of a "dust-free" gas in connection with economizers or gas engines a much-increased efficiency is obtained, resulting in the elimination of considerable boiler capacity, with the further advantage that it is no longer necessary to keep one or more boilers out of commission for cleaning purposes. It has been proved definitely that freeing the gases from dust undoubtedly results in a large saving of the coal employed for power purposes. When the question of finding the most efficient method for removing the dust came up for discussion, it is understood that the well-known Cottrell process of electrostatic dust precipitation was favorably considered, but that, owing to various reasons not fully understood, attention was focused on the Halberg-Beth bag system of dust collection. This is a German-patented process which was taken over by the British Potash Co., the method consisting in bringing about a primary deposition of the coarser dust particles in large iron chambers fitted with a simple "baffling" device which takes out coarse and medium-sized particles, after which the hot gases are filtered through long cotton bags arranged in iron chambers. These bags are provided with a mechanical shaking arrangement for throwing down the dust in order to prevent clogging. In this way the fine dust is collected separately from the medium and coarse. It is found that the heavy coarse dust contains 2 to 3 per cent soluble potash, the medium 3 to 10 per cent, and the fine dust which collects in the bag 10 to 50 per cent. The fine dust (and in those cases in which the potash content warrants it, also the medium sized dust) is then shipped to Oldbury for treatment.

In the bag-house system of dust collection it is obviously important that the temperature of the blast-furnace gases (which issue at about 500 deg. C.) should be reduced to 125-150 deg. C. in order to prevent the cotton bags from being destroyed. The maximum temperature thus must not exceed 150 deg. C., while on the other hand care must be taken that it does not fall below 125 deg. C., since otherwise moisture will be deposited, and clogging will take place. It is evident that considerable

care is necessary to prevent any sudden rush of hot gas, since such might bring about the destruction of the entire bagging equipment. Apparently no steps have been taken to decrease the inflammability of the bag material, although a suggestion has been made to impregnate with either ammonium tungstate or silicate of soda solution. It is claimed that the "bag" should last for about twelve months' continuous operation before renewal is necessary.

Treatment of the Potash Dust

The treatment of the potash dust consists in a simple lixiviation of the material with water (mother liquor from a previous run is employed), the resulting sludge being separated by the use of an Oliver filter. The solution is evaporated, allowed to crystallize, and centrifuged, the product thus obtained containing 80 per cent soluble potash in the form of chloride. No chemical treatment is necessary at any stage of the purification process.

The following typical analysis shows the content of an average sample of the finished product:

	Per Cent.		Per Cent.
KCl	72.16	H_2O	12.36
K_2SO_4	6.65	Insol.	0.25
NaCl	8.56	KCN	0.10
			100.08

It is of interest that the iron ores occurring on the east coast of England contain sufficient chlorides in the original iron ore to insure all the potash volatilizing in the form of chloride, while those on the west coast contain a little sulphur, so that a small amount of sulphate is obtained.

Method of Increasing the Potash Recovery

Experiments carried out by the British Potash Co., Ltd., have shown that the addition of a small amount of common salt to the blast-furnace charge in certain cases increases the yield of potash obtained (British Patent 112,338) which is especially true of ores relatively free from chlorides, and from which in consequence a considerable quantity of the potash would otherwise find its way into the slag. This applies to those ores occurring on the west coast of England, and also to certain Welsh ores.

In one or two instances it has been found that the recovered potash salts may contain a small amount of cyanide, in which case it is necessary to remove the latter by a special process of recrystallization.

List of Potash Recovery Plants in Operation

There are at present three blast-furnace plants collecting dust in bags for the recovery of potash, namely, North Lincolnshire Iron Co., Palmers Shipbuilding & Iron Co., and Ebbw Vale Iron Co. In each of these plants common salt is added to the blast-furnace charge to increase the potash yield. In addition to these, four other blast-furnace plants, viz., Blaenavon Iron Co., South Wales; Barrow Hematite Co.; Baldwin's, Ltd., South Wales, and Millom & Askam, Cumberland, are being equipped with similar installations, while the Ebbw Vale plant has commenced the erection of a second unit.

Cost of Erection and Operating

It is claimed that it is not economical to build an operating unit of bags capable of handling more than 1,000,000 cu.ft. of gas per hr., the present cost of such an installation being £40,000 (approximately $200,000).

No definite statement could be obtained as to the actual cost of operating, but it would seem that the labor cost and the necessary operating power are both higher than in the case of a Cottrell installation.

Recovery of Potash by the Lodge Fume Co. Process

The Lodge Fume Co. has been formed to develop certain patents (for dust recovery from gases) granted to Sir Oliver Lodge, on lines closely related to those of Cottrell, and following the successful small-scale experiments a large plant is now in process of erection at the Skinningrove Ironworks, Yorkshire, which was expected to be in operation in August. It has been designed to treat the entire output of 4,000,000 cu.ft. of gas from the usual closed-top blast-furnace working on local ores, no salt addition being necessary in this case.

The equipment has apparently been planned on somewhat similar lines to the well-known Cottrell installations, namely, a series of vertical iron plates with rods placed centrally. It is intended to operate at 70,000 volts, 7 to 10 hp. being required to run the system. The annual output of potash is expected to amount to not less than 1000 tons of 80 per cent material, and the iron company proposes to erect its own refining plant. It is anticipated that not more than two men and two boys will be required to operate the entire plant.

Cost of Installation

This plant, which is designed to treat 4,000,000 cu.ft. of blast-furnace gas per hour, is estimated to cost £35,000, as compared with £40,000 for a single unit of the bag system capable of handling only 1,000,000 cubic feet.

Recovery of Potash by the Cottrell Process

An experimental Cottrell plant was installed in 1918 by Huntington, Heberlein & Co., Ltd., the British representatives of the International Precipitation Co., at the works of the Workington Iron & Steel Co., Ltd.

Certain alterations in the design were soon found necessary, and these were subsequently carried out, though there was considerable delay owing to difficulties connected with the supply of labor and materials. The reconstructed plant comprises thirty-six 12-in. pipes 15 ft. long, and arrangements have been made so that the blast-furnace gas can be tapped from the main without interfering with the operation of the boiler plant.

The experiments at Workington were the first to be carried out in England on a comparatively large scale, and as is usual under such circumstances, many experimental difficulties inherent to this particular proposition had to be overcome. With the knowledge so obtained, it is now claimed that it will be possible to erect plants of any size required which will operate with an efficiency of 90 per cent or better.

Comparison of the Bag and Electric Systems of Potash Recovery

The outcome of the Skinningrove and Workington experiments is awaited with considerable interest in order that a direct comparison of operating costs may be made between the electrical method of potash recovery and the Halberg-Beth bag system of dust collection. From the above facts it would seem that the cost of equipment and installation of the latter process is roughly four times that of the former, and the operating charges are also apparently higher, due to the increased labor charges and the higher depreciation. Also, the horse-

power necessary to force the hot gases through the filter system is much greater than that required to operate the electrical installation.

In view of the pronounced success of the companies operating the Cottrell system of recovery in connection with cement plants in America, there would seem to be little or no doubt that an equal measure of success would be achieved in connection with the recovery of potash from blast-furnace gases.

No definite information could be obtained as to the present cost of production of 80 per cent muriate of potash, but in view of the increased output in this field and the number of new installations, together with the fact that one plant is already installing additional equipment, the claim of the British Potash Co. that it expects to be able to produce this material at prices low enough to compete with German potash would seem to provide a sufficient stimulus for the large iron and steel companies in America to undertake similar experimental developments.

It is evident from the analysis of typical English ores, quoted below, that the American ores in many cases contain even larger quantities of potash, so that American iron and steel producers should be in a position to achieve equally valuable commercial results.

Potash Content of Typical English Iron Ores

The ores on the west coast contain roughly from 0.2 to 1.30 per cent of potash calculated as chloride of potash, an average sample of the flue dust analyzing approximately as follows:

	Per Cent		Per Cent
Insoluble matter	82.10	Sodium chloride	1.9
Potassium chloride	7.82	Water	8.0

Those on the east coast contain a potash content varying roughly from 0.2 per cent to around 1.5 per cent calculated as chloride of potash, equivalent to 1.3 to 0.95 per cent K_2O. A typical "flue dust" analysis showed:

	Per Cent		Per Cent
Soluble potash (Calculated as KCl)	55.3	Calcium carbonate	10.4
Sodium chloride	4.0	Silica	8.9
Ferric oxide (Fe_2O_3)	11.7	Magnesia	1.0
Zinc sulphide	2.2	Carbonaceous matter, etc.	6.5
			100.0

The potash (K_2O) content of English iron ores may thus be said to vary between 0.126 and 0.98 per cent as compared with American iron ores, which average from 0.29 to 2.07 per cent, according to a large number of analyses run by Mr. N. C. Gellert of the Gellert Engineering Co., Philadelphia, Pa.

Recovery of Potash in Cement Plants

While in England special emphasis has been laid on the extraction of potash from blast-furnace gases, considerable experimental work has also been done on the recovery of potash from the dust in the gases from cement kilns. The somewhat slower industrial development is probably due to the greater activity and interest shown by the blast-furnace operators and the evident fuel economies which can be effected by the use of a dust-free gas. On the other hand, little or no use is at present made of the latent heat in the waste gases from cement kilns, so that this consideration did not, of itself, make the same striking appeal to the English cement manufacturers. An experimental installation is already in operation in connection with the gases from a cement plant operating the wet mix method, in which the bag system of dust recovery is employed, and arrangements have been completed for the installation of a recovery plant in connection with a new modern cement plant of 1600-bbl. capacity, also operating the wet mix process. The type of recovery apparatus to be employed will be definitely decided upon after the relative cost of potash production by the bag system, as compared with the electrical process, has been definitely established. There is reason to believe that rapid progress will be made in this field during the next few years.

Prediction of British Independence in the Potash Field

The Potash Production Bureau of the British Board of Trade is convinced that by the utilization of both sources of production the country will be made entirely independent of outside sources of potash.

While undoubtedly much greater progress has been made in America with respect to economies to be effected in the cement industry by the utilization of the latent heat in the waste gases as well as in the recovery of potash from the dust, there would seem no reason to doubt that much of the gas from blast-furnaces can be similarly treated with correspondingly favorable results from the fuel standpoint as well as from that of potash recovery. The way, in fact, has already been pointed out in the admirable papers by Messrs. Wysor,[1] Gellert,[2] and Bradley,[3] and it now only remains for the iron and steel manufacturers to take advantage of the pioneer work already carried out by Cottrell, Linn Bradley, Wysor, Gellert and others (of whom the scientific and technical work of Linn Bradley, Research Corporation, New York, calls for special mention) to make America economically independent of outside sources of potash production.

Stimulation to Interest Here

The fact that the average American iron ore contains on an average as much as or even more than the average English iron ore should serve considerably to stimulate interest in this matter. Of special interest too are the large deposits of brown hematite ores in Alabama, which are remarkable for their high potash content. By the use of these ores (with possibly salt addition) in ordinary blast-furnace practice and employing the Cottrell process for the recovery of the potash in the dust, it does not seem any exaggeration to assume that the necessary supplies of potash for the entire fertilizer requirements of the South could be provided from this source. Furthermore, the experimental work already carried out by Gellert with manganese ores shows that they contain a much higher potash content than iron ores, and his suggestion that a start should at once be made with such material would seem to represent a sound well-balanced judgment. We understand, in fact, that such a scheme, under his supervision, and with the active co-operation of the Research Corporation, New York, is already under way in one locality.

Conclusion

According to information supplied by the Bureau of Potash Production, England, large-scale experiments on the recovery of potash from blast-furnace gases have shown that:

1. By the removal of the dust from blast-furnace gases, the pre-heating surface for the air blast can be reduced in the ratio of 3 : 5.

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[1] Bull. Amer. Institute Mining Engineers, 1917 (Jan. 17), with subsequent discussions.

[2] Chem. & Met. Eng., vol. 20, p. 308.

[3] Bull. Amer. Institute Mining Engineers, 1917, pp. 209-228; Chem. & Met. Eng., vol. 19, p. 457.

2. A considerable saving in coal consumption and boiler capacity can be effected.

3. The commercial results already obtained in connection with potash recovery indicate that blast-furnace gases are capable of providing a profitable source of potash production under normal competitive conditions.

The International Potash Situation

According to the figures supplied to the writer by the British Bureau of Potash Production, the total exports of potash and potash salts from Germany in 1913 were as given in Table I.

TABLE I.

Total exports of potash and potash salts from Germany in 1913 so far as separate figures are available:

	Metric Tons
Potash and wool grease ash	16,271
Caustic potash	44,112
Chlorate of potash	1,114
Sulphate of potash	133,358
Phosphate of potash	12
Nitrate of potash (saltpeter)	16,058
Manganate and permanganate of potash	1,521
Muriate of potash	393,320
Sulphate of potash and magnesia	59,207
Potash salts for manurial and other purposes:	
Carnallite containing from 9 to 12 per cent K_2O	520
Crude salts containing from 12 to 15 per cent K_2O	1,124,816
Salts containing from 15 to 20 per cent K_2O	49,687
Manures containing up to 38 per cent K_2O	460,865
Waste salts (so-called Stassfurt salts) unenumerated	40,269

Exports from Germany in 1913 of certain groups of chemicals in which potash salts are included with other salts:

	Metric Tons
Bromide of potassium, sodium, ammonium and iron; bromoform	405
Iodide of potassium, sodium and ammonium; iodoform	160
Ammonia, potash and soda alum and other similar products	24,733
Chromate and bichromate of potassium, oxide and hydroxide of chromium	2,627
Water-glass (silicate of potassium and sodium)	15,543
Ferro- and ferricyanide of sodium and potassium	2,294
Cyanide of sodium and potassium	6,678
Sulphide of potassium and sodium	9,226

The value of potash compounds imported into Great Britain from Germany in 1913 is shown in Table II.

TABLE II.

Detailed statement of values of potassium compounds imported into Great Britain from Germany in 1913:

	Value
Bichromate	£974
Bromide	7,827
Carbonate	33,555
Caustic	79,090
Chlorate	2,101
Cyanide	9,763
Iodide	10,351
Lyes	8,762
Meta bisulphite	1,146
Muriate	99,951
Oxalate	1,743
Permanganate	7,451
Phenylglycine	38,832
"Potash pot lye"	2,235
Prussiate	14,781
Potash salts (unspecified)	2,495
Sulphate	85,175
Sulphate muriate	22,935
Cream of tartar	149,562
Saltpeter	156,682
Salts other than the above to values not exceeding £1,000	12,269
Waste salt	50,193
Kainit	117,994
	£915,867

The pre-war imports from other countries are shown in Table III.

TABLE III.

Pre-war imports of potash and potash compounds into the United Kingdom, 1913.

Saltpeter:	Cwt.	Value
Total imports	237,880	£240,966
of which from		
Germany	149,975	156,682
Belgium	25,469	25,023
Br. India	60,006	56,631
Other potash compounds:		
Total imports	.....	£630,234
of which from		
Russia		58,499
Germany	Entered	441,436
Belgium	Only	20,489
France	by	57,115
Sweden	Value	12,634
Japan		30,654

The British Government has already announced its intention to allow the importation during 1919 of about 20,000 tons of Alsatian potash averaging 14 to 20 per cent K_2O. Also a further 50,000 tons of German potash (80 per cent K_2O), which is to be taken in part payment for goods supplied; and it would seem to be the policy of the government not to issue further permits except in so far as domestic supply is insufficient to cover the demand.

According to an interesting article on this subject in the *Chemical Age* (vol. 1, No. 5, 1919), it is claimed that the post-war requirements for potash will be much greater than the pre-war requirements, and that while the former cost of production of 80 per cent potash is assumed to have been approximately £7 per ton, it cannot be expected that a lower price than about £15 to £25 per ton will be the rule for a considerable period of time.

This surmise is based on the assumption that for many years to come the world's requirements of potash will be far greater than can be met by the combined output from the Alsatian and German fields.

Attention is also drawn to the reported occurrence of rich potash deposits in the Italian colony of Erythrea, Abyssinia,[4] some hundreds of tons of this material with a chloride of potash content of 75 to 95 per cent having been exported during the war period. The extent and uniformity of these deposits, as well as of similar ones in Spain and Sicily, are still matters for investigation.

Of possible interest is the reference in the same article to the extraction of potash from leucite by a new Italian process. Leucite is a double silicate of potash and alumina containing, when pure, about 28 per cent K_2O, but the Italian product generally contains only 8 to 10 per cent. According to the new method the gangue can be separated electromagnetically, thus increasing the K_2O content to 15 per cent.

The writer wishes to express to the officials of the Department of Potash Production, Board of Trade, England, his appreciation of their kindness in favoring him with the major portion of the data outlined above. It would appear that no small amount of the success obtained is due to the energy and enthusiasm shown by them.

360 Garden Avenue.
Mount Vernon N. Y.

Belgian Wage Scale

The past and present labor situation in Belgium, which might serve for comparison with that in the United States, is given in the following news item taken from the *Fortnightly Information Review*, Nov. 1, 1919:

"In general, the present wage scale in Belgium, as compared with June, 1914, shows an increase from 150 to 200 per cent, according to Trade Commissioner Harry T. Collins, Brussels. Blacksmiths, machinists, etc., employed by the community receive 19 to 24c. an hour, which is an increase over 1914 wages of 225 to 285 per cent for an 8-hr. day. Carpenters receive 23c. an hour for a 54-hr. week, which is an increase of 153 per cent over wages in 1914. Mechanics employed in textile factories receive 18 to 22c. an hour, an increase of 261 to 294 per cent over their wages in 1914, with an 8-hr. day."

[4] *J. Soc. Chem. Ind.*, 1918, 291T.

Treating Antimony Ores*

BY GEORGE P. HULST†

PRIOR to 1914 there was little demand for antimony in this country; its use was limited almost entirely to the manufacture of type and bearing metals. Practically no antimony ore was mined here, the market being supplied principally from China, and the alloy was produced by a direct mixing of lead and antimony. The great world war, with its demand for shrapnel in hitherto undreamed of quantities, precipitated a great boom in the price of antimony. Nominally quoted at 6c. to 7c. in 1914, the price increased by leaps and bounds to 45c. in March, 1916. Under the stimulus of high prices many small mines were opened, for it became profitable to work ores containing as low as 20 per cent antimony. High-grade sulphide ores (stibnite), containing 55 to 60 per cent antimony, were received from Bolivia, China and Alaska. Low-grade sulphide ores, running from 20 to 45 per cent, were produced in Nevada, California, Idaho, Utah and Mexico; much of this ore was fairly rich in silver. The principal oxide ores came from Mexico and Oregon. The following analyses are representative of various types of antimony ore:

	Sb	Pb	Cu	Ag	Au	SiO_2	Fe	S	CaO	Zn	As
Oxide ore...	25.09	.....	....	....	....	46.02	0.95	0.40	10.98	0.30	0.22
Sulphide ore	55.20	.....	....	....	....	15.12	1.05	19.87	.....	0.40	0.25
Sulphide ore	37.16	11.30	0.10	34.0	....	7.60	0.50	17.05	7.40	0.36	0.10
Sulphide ore	41.55	18.00	0.20	76.0	0.04	5.60	0.25	18.17	0.85	0.25	0.10

The International Lead Refining Co. fortunately was equipped to handle these ores through residue and blast-furnaces. The charge consisted of a variety of sulphide ores containing Sb 20 to 60 per cent and SiO_2 6 to 45 per cent, oxide ores containing Sb 20 to 40 per cent and SiO_2 10 to 45 per cent. Secondary materials, such as battery plates, battery mud, lead oxide, paint, etc., together with refinery skins, softener skins and other refinery by-products, were treated along with the antimony ore to furnish the lead required. All silver-bearing antimony ores were treated in the residue furnace, the sulphur, iron and copper forming matte that carried part of the silver, the balance going into lead bullion. The antimony slag produced was sufficiently low in silver to warrant being smelted in the blast-furnace to antimonial lead.

The blast-furnace equipment consisted of two 5-tuyere, 42-in. round furnaces connected by flue to the bag house. On account of high zinc and arsenic in lead refinery by-products, we ran a slag of the composition SiO_2 26 per cent, FeO 40 per cent, CaO and ZnO combined 20 to 24 per cent. Net profit rather than metallurgy prompted a slag as low as possible in antimony, even though the lead content was increased. Average analysis of slag for 6 mo. showed Sb 0.66 per cent and Pb 2.36 per cent. Actual blast-furnace loss was 2.4 per cent antimony and 1.503 per cent lead. Due to sulphur and arsenic on the charge, some speiss was produced. The furnace charge varied from 2500 to 3000 lb. Coke ratio was 13 per cent. Blast pressure was maintained at 10 to 12 oz. The two furnaces smelted 60 to 90 tons of lead and antimonial material per day, producing 30 to 35 tons of antimonial lead of the following average analysis: Sb 13.00 per cent, Cu 0.15 per cent, As 0.75 per cent, Pb 86.1 per cent.

*Read at the Chicago meeting of the American Institute of Mining and Metallurgical Engineers, Sept. 24, 1919.

†Assistant general manager, International Lead Refining Co.

Need of Extensive Research in the Petroleum Industry

BY VAN H. MANNING

THE welfare of any industry must be considered in connection with the welfare of the people. Capital and labor cannot disregard the public; that must be represented and considered. A review of the American petroleum industry shows that the industrial development and general prosperity of the United States depend upon an adequate supply of petroleum. It was one of the prime factors in assuring victory for the armies of the Allies, and today our automobiles, trucks, farm tractors and motor boats are dependent on it for power, and few manufacturing industries can exist without it. There are no known commercial substitutes for gasoline or lubricating oils, and, in fact, petroleum in one form or another reaches every household in the civilized world. As to the future, it is certain that the demand for petroleum will increase.

Faced with this growing need for petroleum, we have to consider seriously the means whereby an adequate supply for the future can be obtained. We know that the domestic output does not meet the present consumption, and that the amount of this deficit will probably continue to increase. Of the original available supply underground, it is estimated by the U. S. Geological Survey that we have consumed 40 per cent that is unreplaceable. A diminishing output with increasing consumption will make the United States more dependent on foreign fields.

It is true that there are vast oil reserves in foreign countries, and if these fields could be developed without hindrance, they could, even though consumption continues to increase at the present rate, probably meet the world's demands for the next ten years at least. Prediction beyond the ten-year period is not safe, for too many uncertainties are involved.

In meeting the world's needs, however, the oil from the United States will continue to occupy a less and less dominant position, because within the next two to five years the oil fields of this country will reach their maximum production and from that time on we will face an ever increasing decline.

DOMESTIC OIL FIELDS UNABLE TO MEET PRESENT HOME DEMANDS

We thus see domestic oil fields unable to meet our home demands under present methods of utilization and manufacture. This startling fact cannot be ignored. We must and can obtain a more efficient utilization of petroleum by proper investigative work. Research work and scientific development work should be actively stimulated.

Our efforts should tend toward obtaining perfection in processes, mechanical equipment, and in the proper development of our plants and processes. The day of empirical formulas and rule-of-thumb methods should not be passively allowed to continue. It is only a scientific research and the adoption of methods pointed out by this research in which natural laws form a basis for the quality and value of any product that we can hope to obtain the most valuable products out of petroleum.

Today there are many laboratory processes which have not been developed further simply because of insufficient funds to install them commercially. One object of research would be to test out on a commercial scale

many of the laboratory processes now dormant commercially because of insufficient funds. Another object of research should be to correlate the pertinent facts of all investigative work and start supplemental research at the point where it is needed. This procedure will avoid costly repetition. The result of all past and current work should be properly correlated and brought under one large head, so that the greatest good can be accomplished and duplication minimized.

Research and Exchange of Information Needed

It is the research man who should point out the manufacturing losses, and indicate the necessary investigative work whereby these losses will possibly be reduced or eliminated. These results should not be stored in the records of one company, but should be available to other manufacturers, so that they may profit by the experience and findings of their neighbors. A proper exchange of information must save much costly duplication of work.

The petroleum industry, valued at billions of dollars annually, is essential to national efficiency, and national efficiency can be attained only through scientific research. The necessity of such research is becoming recognized more and more by the large industrial units, some of which spend thousands of dollars annually for scientific investigations. Many petroleum organizations have scientific bureaus, but much of the knowledge these bureaus gain is confined in the archives of the company's laboratory.

The need of research is recognized in many professions, and particularly in medicine. The medical profession is essential to personal health and life, and vast sums of money have been donated to medical research. As a result, typhoid fever, smallpox and many other deadly diseases have been mastered. The money donated to medical research has been refunded many times over through the saving of life and the increase of human efficiency, and intensive research in the petroleum industry would yield results incomparably more valuable than the cost of the work. A fraction of the sums spent in medical research would, if expended in petroleum investigations, bring about improved methods that would vastly increase efficiency in the utilization of each barrel of oil. In 1918 the value of the output of crude oil and refined products in the United States was about $2,500,000,000. Certainly the petroleum industry can afford to spend more than has heretofore been spent in research to discover new methods and perfecting those in use, for thereby the recovery of oil will be increased and utilization will be far more efficient. In this way the cost to the consumer will be lessened and a rapidly diminishing commodity, one essential to our existence, will be conserved.

Secretary Lane Quoted

In conclusion, I do not believe that this problem could be emphasized any more strongly than has been done in a letter to me from Secretary Lane, of Sept. 24, from which I quote the following paragraphs which have a direct bearing on the above subject:

"It is not an exaggeration to say that millions of dollars must be spent in experiment before we know the many services to which a barrel of oil can be put. There is almost an indefinite opportunity for research work along this line. Petroleum is a challenge to the chemists of the world. And now the world is dependent upon it as it is upon nothing else excepting coal and iron, and the foodstuffs and textiles. It has jumped to this place of eminence within twenty years and the world is concerned in knowing how large a supply there is and how every drop of it can best be used.

"We are behind the rest of the world in the use of our oil for fuel purposes. We are spendthrifts in this as in other of our natural resources. We can get three times as much energy as we do out of our oil through the use of the Diesel engine, yet we are doing little to promote development of a satisfactory type of stationary Diesel, or marine design. Instead of seeing how many hundred millions of barrels of oil we can produce and use, our efforts should be to see how few millions of barrels will satisfy our needs."

Requa Sees Dawn of "Real Petroleum Era"

The views of Mr. M. L. Requa, in a letter to me of Sept. 25, have such an important bearing on this great topic that I think it well also to add a few pertinent statements from his letter on this subject.

"I am on record in various published addresses as to my attitude concerning the petroleum problem, and I think it unnecessary to repeat those statements. I cannot, however, refrain from pointing out briefly the acute need that I believe exists for constructive and co-operative work of the character that you are proposing. That it has never been done before has been due to two causes: one, the less pressing need, and the other the lack of realization upon the part of the industry of the necessity for co-operative and constructive action.

"Because of the tremendous increase in the consumption of petroleum products, we have confronting us problems that have been of little concern in the past, but will be of very much greater concern in the future. Satisfactory answers cannot be made, except through constructive action upon the part of the industry. There is no alternative, in my judgment.

"We are, in my judgment, just beginning to see the dawn of the 'real petroleum era.' All signs point to a demand for the product in the future that will far exceed anything in the past. I am optimistic enough to believe that the Diesel engine will be perfected, and become of universal application. If so, the day of the steam unit will have passed.

"The extraction from a barrel of oil of all of the component parts, so far as is commercially practicable, and the distribution of those products in channels of trade, in a useful and economical way, rather than their destruction as is now the case, is a matter of highest concern."

Government Assumes Responsibility for Failure of Castor Bean Crop

More than 18,000 Southern farmers are to be reimbursed for losses sustained in efforts to raise castor beans for the Government. The Board of Contract Adjustment of the War Department has ruled that the Government in furnishing seeds, of which a large percentage failed to germinate, had incurred liability and that the case comes within the purview of the informal contract act. The Government undertook the stimulation of castor bean growth early in the war when it appeared that a sufficient amount of castor oil would not be available for use as a lubricant for airplane engines. The seeds were secured in India and proved to be unsuited to climatic and soil conditions in the U. S.

Relationship Between Transverse Rail Fissures, Flakes and Defects in Fusion Welds

A Consideration of These Apparently Diverse Imperfections Indicates the Strong Probability That All Are Due to One Cause: Films of Oxide Between the Metallic Grains—Examination of Defective Rail and Gun Steel Under Strain Would Probably Throw Much Light on This Point

BY S. W. MILLER*

THE subject of transverse fissures in steel rails is one which is of vital interest, not only to the railroads, but to everyone who travels on them. A very great amount of work and time has been spent trying to determine their exact nature, and especially their cause; and a large amount of information has been secured in regard to them by competent observers who have every opportunity for so doing.

At the meeting of the American Institute of Mining Engineers in February last, George F. Comstock presented a paper on this subject, and the Rail Committee of the American Railway Engineering Association has recently reported on the matter, an abstract of its findings appearing in the *Engineering News-Record* of March 27, 1919, p. 610. Mr. Comstock's paper and the report of the Rail Committee contain probably the latest information in regard to transverse fissures.

The difficulty experienced with flaky gun steel has been considerable, at least in America, and a great amount of investigation has been carried on in order to determine the cause and eliminate the trouble. Of course, its prominence has been aggravated by the greatly increased demand for gun forgings during the war. Two papers on the subject were presented at the February meeting of the American Institute of Mining Engineers, which attacked the trouble from different standpoints, and which were thoroughly discussed. In the issue of CHEMICAL & METALLURGICAL ENGINEERING for March 15, 1919, there is a very important article by Dr. Giolitti, the Italian metallurgist. These articles contain probably all of the important information in regard to flaky steel.

It may seem a far cry from the above two subjects to that of fusion welds, but, as the materials in which the two former defects occur are originally steel castings, and as a fusion weld is the same thing except on a smaller scale, it would seem reasonable that the defects in all three cases would be of the same general nature, although likely to be aggravated in the case of welds because of the lesser degree of skill and knowledge possessed by the average operator, and from the fact that but little attention has been given to defects in welds and to the methods of their prevention. The writer presented a paper at the February meeting of the American Institute of Mining Engineers in this connection. Since that time he has made further examination of heat-treated welds, and finds no reason to change his conclusions in the paper.

Furthermore, as bearing on the general subject, attention is called to a paper by J. C. W. Humfrey, on "The Intercrystalline Fracture of Iron and Steel," in the Carnegie Scholarship Memoirs, Iron and Steel Institute (1912), vol. 4, p. 80, and also to Mr. Humfrey's discussion of the paper by Prof. Zay Jeffries on "The Metallography of Tungsten" in the November *Bulletin* of the American Institute of Mining Engineers.

Short abstracts from all these references are given herewith in order to sustain the position which the writer has taken in regard to these defects, which briefly is that *they all result from the same cause, which he believes to be films of oxide, or other foreign matter, which lie along the grain boundaries and which impair the physical qualities of the metal.* These films may be so thin as to be ultra-microscopic, and yet may have a serious effect.

In Mr. Comstock's paper, the statement is made that there are two schools whose opposing beliefs are: first, that transverse fissures are the result of fatigue and independent of the quality of the metal; second, that the quality of the metal and the mill practice must have something to do with them. Mr. Comstock associates these fissures with high-phosphorus streaks, using 24 rails having them and 12 rails giving good service as a basis, and also concludes that reheating the rail blooms reduces the tendency toward forming transverse fissures. He does not take the position that the fatigue theory is disproved by his investigations, and attempts to reconcile the two opposing theories by showing that both are probably closely connected with the formation of fissures. He also states in closing that his "paper is presented with the idea of throwing a little light in a new direction on the internal conditions that help the beginning of transverse fissures in rails." In other words, Mr. Comstock tries to find the *starting point* of the transverse fissures found in service, and suggests strongly that segregation due to phosphorus is a probable contributing cause.

LATEST INFORMATION ON DEFECTIVE RAILS

The statements of the Rail Committee are well summarized in the *Engineering News-Record* of March 27, 1919, in "Progress in Study of Rail Quality":

> First—Mr. Waring's statement that deep etching as carried out by him on rails found with fissures either in service or during test brings out irregular markings associated with the fissures. He also states that a rail that performed well under test, though from the same heat as some of the defective rails, showed none of the markings. His conclusion is: "Since these rails were all from one heat, of a fairly uniform chemical composition, and rolled at the same time, and since they were all subjected to approximately the same amount of service in the track, it would appear as if these defects found in the rail heads are associated in some manner with the process of manufacture." And further: "An examination of all these deep etchings brings out the fact that these small internal transverse ruptures correspond in their location and appearance with

*Proprietor, Rochester Welding Works.

the nuclei of transverse fissures, and it is possible that they may be the original cause of such fissures."

Second—Mr. Young's closely allied statement is that his findings "are conclusive evidence that flaws and cracks exist in new rails which have been subjected to no strains except those developed in the rolling."

Third—Mr. Cushing's report as to the very much better quality of rails from some mills than others, based on the comparison of elastic limits and deflections, and that annealing removes the brittleness and increases the deflection. Dr. Dudley also makes the same statement with regard to annealing.

Fourth—The percentage of transverse fissures in direct rolled rails is ten times that found in rails from reheated blooms. In the latter there was one fissure per 5466 tons, and in the former one fissure per 531 tons.

Fifth—There is a strong belief that small cracks are produced in rail heads during the gagging.

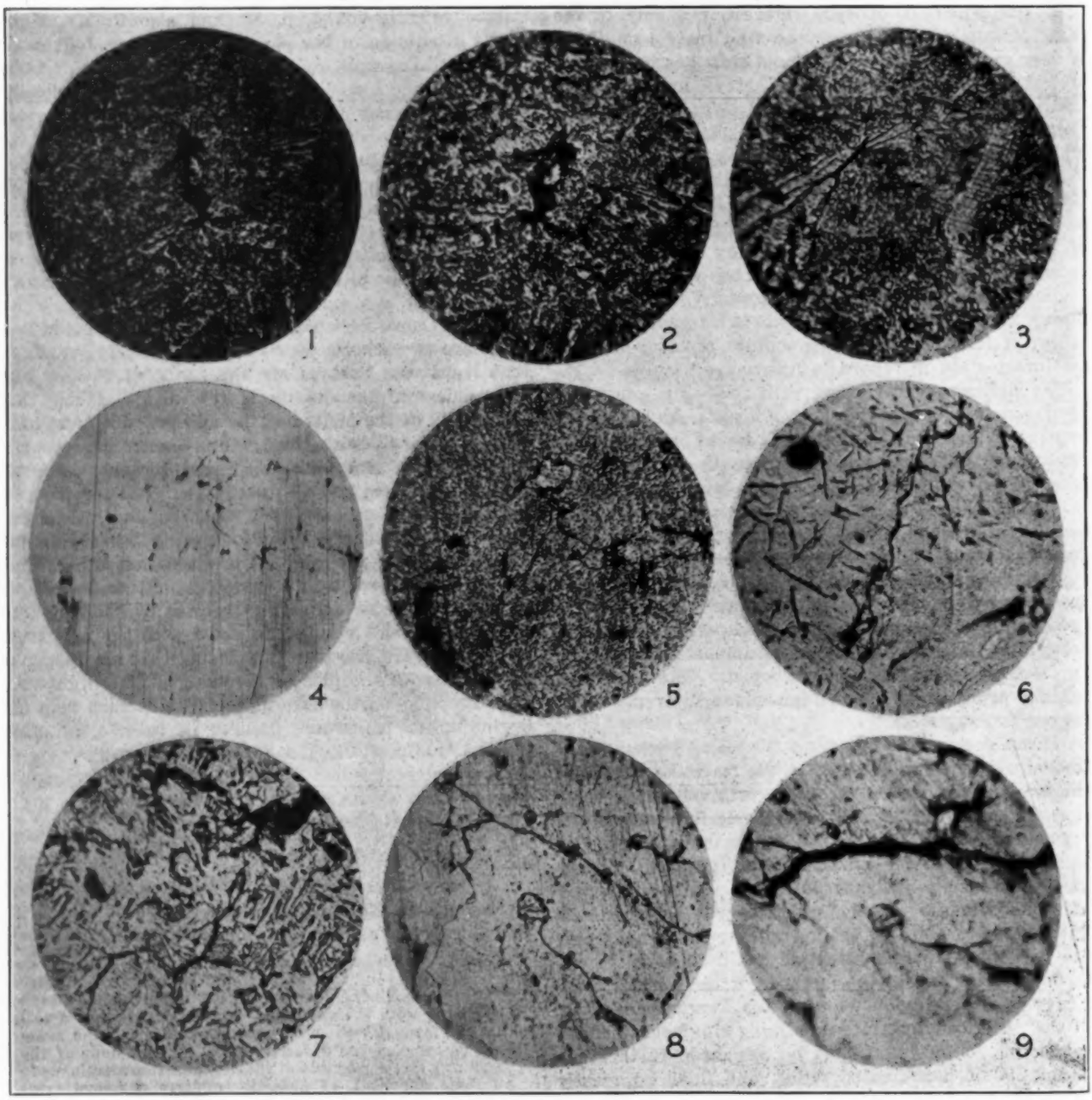
With regard to flaky steel, the paper[1] by Mr. Clayton and his associates suggests seven possible causes, of which they seem to lean strongly toward No. 5, which is "overheating and non-uniformity of heat of ingot preparatory to forging."

The paper[2] by Mr. Rawdon concludes as follows:

"On the whole, the microscopic appearance of flaky steel leads to the following conclusions regarding the nature and origin of flakes. They originate in the ingot, in which state they have the appearance of inter-

[1] "Flaky and Woody Fractures in Nickel-Steel Gun Forgings," by Charles Y. Clayton, Met.E., Rolla, Mo., Francis B. Foley, Pittsburgh, Pa., and Francis B. Laney, Ph.D., Washington, D. C.

[2] "Microstructural Features of Flaky Steel," by Henry S. Rawdon, Washington, D. C.



FIGS. 1 TO 9

Fig. 1. Flaky gun steel. First evidence of distortion at two dots of manganese sulphide. × 430. Fig. 2. Same as Fig. 1 after further strain. No evidence of defects other than manganese sulphide before strain. × 430. Fig. 3. Rupture in ferrite grain boundary in flaky gun steel. No evidence of defects before strain. × 1200. Fig. 4. Defect in flaky gun steel beneath flake about $\frac{1}{8}$ in. from the flake. Unetched. × 200. Fig. 5. Same as Fig. 4 etched with nitric acid. × 200. Fig. 6. Intergranular rupture in electric weld as made. The needles are nitride of iron. × 430. Fig. 7. Intergranular ruptures in electric weld quenched from 1800 deg. × 430. Fig. 8. Oxide films in oxy-acetylene weld before straining. × 430. Fig. 9. Same as Fig. 8, but after strain. × 430.

crystalline shrinkage cracks. They occur in the cast metal along with the slag inclusions in the angles between the branches of the tree-like dendritic crystals. They persist throughout the history of the forging into the finished form as discontinuities in the metal, often associated with slag films, which have resulted from the working down of the slag inclusions with which they are associated from the beginning."

The present writer is strongly inclined to believe that the usual cause of flakes is as explained by Mr. Rawdon, but it would seem quite plausible that at times overheating of the ingot, as referred to in the paper by Mr. Clayton, would cause similar defects which would not be removed during subsequent forging. As evidence of this, the statement made by Mr. Humfrey in discussion of Prof. Jeffries' paper, and appearing in his original paper,[3] shows that intercrystalline brittleness can be produced by overheating, and this brittleness again removed by heating in a reducing atmosphere, such as that of hydrogen. Mr. Humfrey's statement referred to is as follows:

> We do, however, know of cases in which certain metals, which normally break through the crystals, may be so altered in character as to tend to break around them. Typical examples of this are:
> (*b*) Pure iron which has been annealed at certain temperatures and in certain atmospheres, and slowly cooled through a certain range. In this case there is evidence to indicate that the weakness is due to the formation of an iron-oxide eutectoid.

Mr. Humfrey was unable to find any microscopical evidence of oxide films around the grains even at high power, yet since the heating in a reducing atmosphere caused the rupture to pass through the grains, as in normal steel, he felt that these films must exist.

Dr. Giolitti's Opinions

Dr. Giolitti's entire article is worthy of the most careful perusal, especially the following statements:

> Flakes originate in tender alloy steels as intercrystalline cracks, probably intensified by inclusions and segregations. They can consequently be controlled by careful steel furnace practice, casting, soaking, reheating, forging and heat treating. . . .
>
> Of even greater importance, however, we feel that free iron oxide (scale and rust) be kept at the lowest possible point in the raw materials charged in the furnace. This refers to scale on the surface of the metal (rusty turnings and borings are never used) and free oxide in the puddled iron itself. . . .
>
> Starting from this pure iron, extreme care is used to prevent superficial oxidation during melting by maintaining a reducing flame in the open-hearth furnace at all times. . . .
>
> What I wish to emphasize is that chromium steel, properly made of pure materials in this manner under reducing conditions and containing no oxide, will never develop flakes. When so made you can pour it into an ingot of any cross-section and forge it as you like—either fast or slow, with reheating or without, with great or slight reduction (always providing the work is done within the correct temperature limits and with usual skill) and flakes will not appear. . . .
>
> On the other hand, a bath of metal properly made from correct raw materials will develop woody structure excessively if only a few kilograms of scale are thrown into the furnace even a long time before tapping. Microscopic examination of this defective metal seldom reveals an increased amount of inclusions, still we feel that this "oxidized metal" is flaky by virtue of its content of emulsified iron oxide, or some substance produced thereby which has diffused or broken up beyond the detection of a microscope.

There are many other statements in Dr. Giolitti's article that are equally positive, and which all point to the fact that oxide is responsible for flaky steel.

The examination of welds made by the writer, and which are summarized in his paper already referred to, was made by bending sections of welds about $\frac{3}{8}$ in. wide and $\frac{1}{8}$ in. thick, and examining them at different stages under the microscope. The same method applied to flaky steel showed two things: first, that the first evidence of rupture was at visible defects, such as dots of oxide or manganese sulphide; second, that where these defects did not exist, the first evidence of rupture was in the ferrite around the grain boundaries. As illustrating these points, photographs Nos. 1, 2 and 3 are shown. In none of the pieces from which these photographs were taken was any defect visible at 1200 magnifications that had the appearance of a crack or film of oxide.

Rupture in Welds Due to Oxide Films

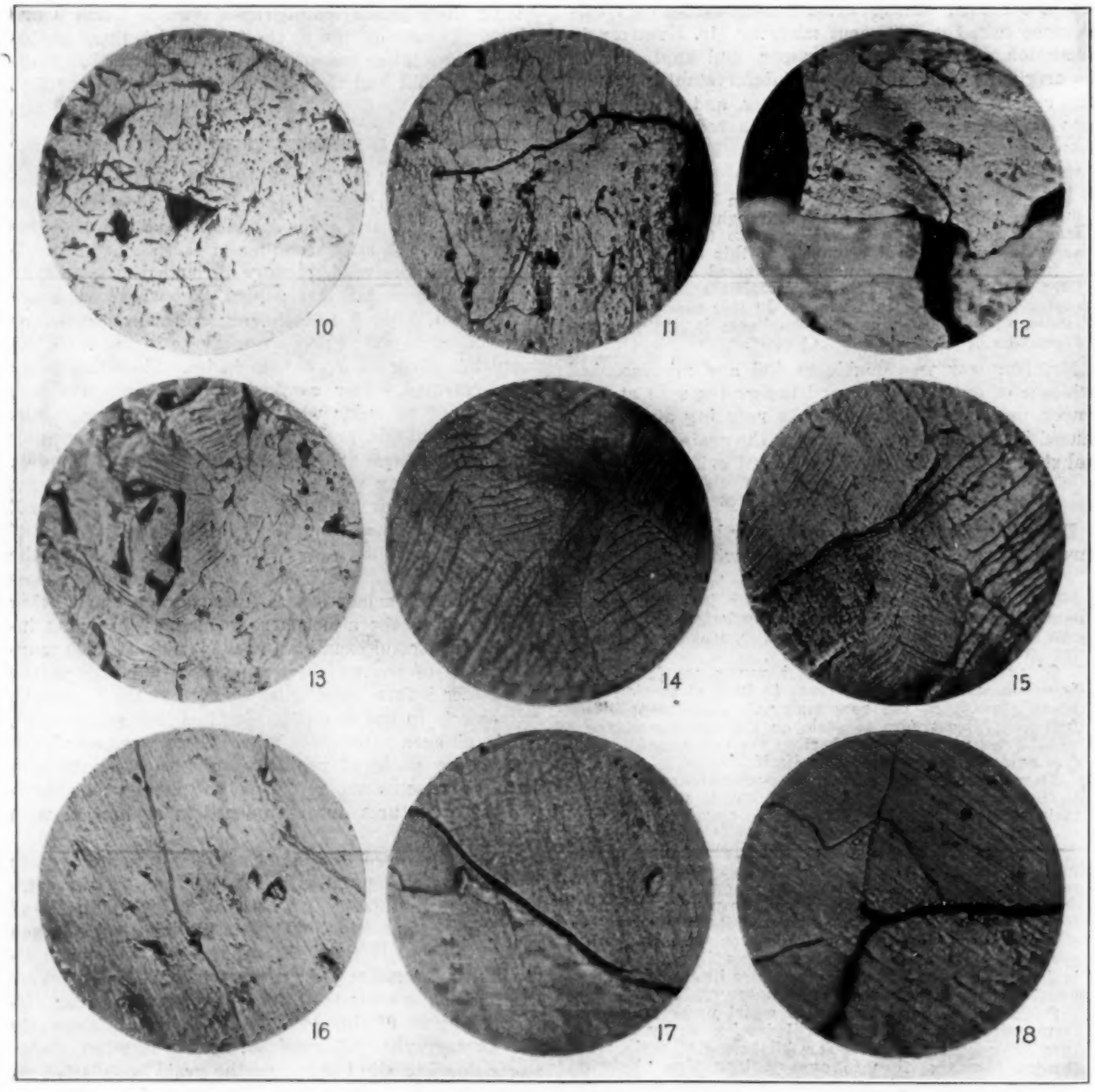
Coming now to the matter of welds, in his paper the writer concluded: first, that all metal-electrode arc welds rupture at the grain boundaries; second, that gas welds made with low carbon material, so that no pearlite exists in the weld, rupture through the grains by slipping as in normal steel; third, that where welds are made from welding rods having sufficient carbon, or other elements which preserve pearlite in the weld, the rupture is along the grain boundaries. Since this paper was presented, other conclusions have been reached, which apply to welds which received heat treatments. These conclusions are: first, that neither quenching from temperatures ranging between 1500 and 1800 deg. F. nor annealing within the same range will prevent the intergranular rupture of electric welds; second, that annealing pearlitic gas welds changes the path of rupture from intergranular to intragranular along the slip planes. The heat treatments referred to were done in an ordinary small electric furnace, no attempt being made to keep the atmosphere reducing. In many instances, a careful examination was made at 1200 magnifications of the polished and etched surfaces of the test pieces before bending in order to locate if possible any defects in the way of oxide films that might exist, but in all such cases, even where there were no visible defects, the paths of rupture were in accordance with the above conclusions. A few of the photographs showing these ruptures are reproduced in connection with this discussion.

It is well known that Armco iron is practically pure iron, the total impurities being less than 0.1 per cent. It has one peculiarity, as have all other materials of the same composition, which is its brittleness when heated to about 1700 deg. F. The writer made some attempts to determine the reason for this brittleness by heating pieces of it to different temperatures for different lengths of time, and finds the results shown in the photographs. Normal Armco iron when under strain develops slip bands, and the grain boundaries remain intact as in Fig. 14. When heated to 1700 deg. F. for ten minutes and quenched in ice water, the grain boundaries appear to be thickened, although it is difficult to judge this positively, the number of slip bands developed is much less than with normal material, and the giving at the grain boundaries is quite frequent. (See Fig. 15.) When heated to 1700 deg. F. and cooled

[3] J. C. W. Humfrey: "The Intercrystalline Fracture of Iron and Steel," Carnegie Scholarship Memoirs, Iron and Steel Inst. (1912), vol. 4, pp. 80-105.

slowly to 1600 deg. F. and quenched in ice water, there appear to be films around the grains as shown in Fig. 16. Under strain the ruptures were clearly intergranular, as shown in Fig. 17. Another test that was made was to heat a piece, ⅜-in. x 2-in., with an oxy-acetylene torch to about 1700 deg. F. and then to strike the piece while red hot on the end of an anvil. The heated section broke off short when struck, and the piece was caught in a tank of ice water. In a section prepared for the microscope, for a short distance back of the fracture the piece was seamed with grain boundary cracks in which in the unetched section material resembling oxide could be easily seen at high power. Etching the section showed that these defects were at the grain boundaries as in Fig. 18.

These tests appear to show quite clearly that it is possible to produce in the normal iron a condition which is abnormal, and it appears that this condition is due to films around the grains. A similar condition is well known to exist in tool steel, and enough overheating does produce what is commonly called burnt steel. The cause of these films is not known, but the writer offers the theory that they are ultra-microscopic in many cases, and possibly of iron sulphide, due to the small



FIGS. 10 TO 18

Fig. 10. Intergranular rupture in normalized electric weld. The spots resembling pearlite are probably iron-iron nitride-eutectoid. The needles are iron itride. No defects visible in 6, 7, or 10. × 300. Fig. 11. Intergranular rupture in oxy-acetylene weld after slight strain. No evidence of films before straining. × 300. Fig. 12. Some as Fig. 11, but after heavy strain. × 300. Fig. 13. Same as Fig. 11 after normalizing. Distortion is by slipping in the grains. × 300. Fig. 14. Armco iron after straining. Distortion is by slip bands. × 300. Fig. 15. Armco iron heated to 1700 deg. and quenched in ice water. Distortion of grain boundaries increased. × 300. Fig. 16. Armco iron heated to 1700 deg. F., slowly cooled to 1600 deg. F., and quenched in ice water. Films appear around some of the grains. × 850. Fig. 17. Same specimen as Fig. 16 after straining. Few slip bands. Distinction heavy at grain boundaries. × 850. Fig. 18. Armco iron heated to 1700 deg. F., broken when brittle and quenched in ice water. Rupture intergranular. Oxide deposited around grain boundaries probably after rupture. × 850.

amount of manganese in the iron. The large rupture in Fig. 18 is probably due to the forcing open of the grain boundaries by the strain and the admission of air, which causes oxide to form.

Conclusions

Considering all the facts above presented, it seems to the writer quite clear that the following conclusions are justified:

First—That nothing in the evidence so far presented is inconsistent with the theory that transverse fissures, flakes and intergranular ruptures in welds are due to the same cause, that is, films, possibly ultra-microscopic, of oxide; also that it is the only theory that appears to fit all the facts.

Second—That these films of oxide may be present in the ingot and usually are.

Third—That these films of oxide may be caused by overheating of the metal at some stage of the process of manufacture.

Fourth—That if they are caused by the presence of oxide of iron in small amounts only, such as probably causes woody steel, they can be removed by proper heat treatments, such as are stated by Dr. Giolitti and Mr. Humfrey; but if they are caused by larger amounts of oxide of iron, which would form considerable quantities of oxide film, then such heat treatment will probably not remove them.

Fifth—That it appears probable that better mill practice will result in the elimination of flakes and also of transverse fissures.

Sixth—The writer knows that such defects in welds as are visible under the microscope can be entirely eliminated by proper welding methods, which involve nothing but thorough fusion and floating all the oxide and dirt, which is clearly visible during the welding operation, to the surface. In electric welds, this procedure is more difficult because the metal is being constantly added from the electrode, and, in addition to this, the oxidizing conditions are exceedingly severe, as the metal passes through the air in the form of vapor and must become seriously oxidized. It is quite possible that ultra-microscopic films in welds may be removed by heating in a reducing atmosphere.

Seventh—The writer would suggest the examination of rails known to contain transverse fissures that have been in service by polishing and etching small sections and bending them under the microscope. He feels that such an examination would throw some additional light on the matter. He would also suggest that the same tests be applied to sound rails, to rails that show little elongation under the usual tests, to gun forgings and to other samples of steel that do not meet specifications, especially those giving low elongation. It is the writer's experience that welds properly made with good materials will, in a test piece ½ in. thick, give from 22 to 30 per cent elongation in the weld; while welds containing oxide films, though invisible, will give an elongation of from 2 to 10 per cent. The same low elongation appears to be characteristic of flaky steel and defective rail material.

Rochester, N. Y.

[Editor's Note—In fairness to Mr. Miller, we wish to point out that his conclusions and those set forth in Chemical & Metallurgical Engineering, Aug. 1, 1919, p. 145, were arrived at by each writer in an entirely independent manner, and in fact Mr. Miller's manuscript antedates the one published Aug. 1.]

Wood Alcohol—Co-operative Caution

By Charles Baskerville

Chairman, Committee on Occupational Diseases, American Chemical Society

UNSCRUPULOUS persons have been selling mixtures containing wood alcohol, as such, or ethyl alcohol denatured with wood alcohol, as beverages. Co-operation of the chemical profession is sought to minimize this infraction of the law.

During the penumbra of prohibition the word alcohol has exercised a weird and unfortunate influence, oftentimes through failure to appreciate the significance of such qualifying words as "wood," "methyl," and "denatured." Numerous cases of blindness and even death have resulted through ignorance or the infamy referred to. The Commissioner of Internal Revenue has as a result issued the following notice:

> To the Collectors of Internal Revenue and Revenue Agents in Charge:
>
> T. D. 2914, issued today and showing additional matter to be affixed to containers of completely denatured alcohol, is called to your especial attention.
>
> Reports recently received in the Bureau establish that completely denatured alcohol is being used extensively for bathing and rubbing purposes. This is contrary to the law and regulations, and such uses cannot be tolerated, as the completely denatured alcohol is highly injurious to the skin and animal tissue.
>
> It is also established that completely denatured alcohol is being sold by irresponsible dealers under circumstances as to assure them that it is being used for beverage purposes. Where it is so used for any length of time blindness inevitably ensues, and the continued use can only result in death.
>
> Collectors should use every means at their disposal to make known to the public the dangers of either external or internal uses of completely denatured alcohol. Wherever collectors or revenue agents in charge hear of a misuse of completely denatured alcohol, a most thorough and careful examination should be made immediately and all the facts fully reported to the Commissioner for the infliction upon the responsible parties of the ultimate penalties provided by law.
>
> In view of the grave and extended abuses of the use of completely denatured alcohol reported, it is deemed necessary to print upon the labels affixed to wholesale and retail packages a further and more specific warning as to its use than is shown on the present required label.
>
> In addition to the present matter on the labels there will be required on all new labels hereafter the printing, in large letters in red ink, under the skull and bones symbol, the word poison, and at the bottom of the label there will be printed the following statement:
>
> "Completely denatured alcohol is a violent poison. It cannot be applied externally to human or animal tissue without seriously injurious results. It cannot be taken internally without inducing blindness and general physical decay, ultimately resulting in death."
>
> Until the present stocks of labels are exhausted, this additional matter may be affixed to the containers on a separate label pasted above the present required label.

We chemists know that we daily handle poisons of various kinds, many far more dangerous than wood alcohol, and there are comparatively few evil results from their handling and use. People do not drink them. The medical profession administers daily to patients many substances that are poisons except in the minute doses given. But in the case of alcohol, the "kicker," in drinks of quondam familiar kinds, means just that one desired fluid, hence attendant danger. We should do all in our power to protect those who use and some likely to abuse this important chemical and thus incidentally avoid lurid appeals with consequent hampering legislation.

College of the City of New York.

An Improved Orsat Apparatus for Gas Analysis*

BY G. W. JONES† AND F. R. NEUMEISTER‡

IN RESPONSE to many queries regarding apparatus used at the present time by the Bureau of Mines for general gas analysis, this article is being published with the hope that some of the difficulties now being encountered by those who have had occasion to do gas analysis may be overcome. The authors do not claim originality for the apparatus described other than the few refinements indicated. The apparatus originally designed by Orsat was modified by Burrell and Oberfell,[1] using Jager's copper oxide method for removing hydrogen and carbon monoxide. In this paper especial emphasis is laid on the general plan of wiring, the supports for raising and lowering the burette leveling bulb and adjustment of same, the adjustable brackets for supporting the pipettes and the method of illumination to aid in bringing the reagents to the marks.

It is assumed that the reader is familiar with the general procedure of gas analysis; therefore this part will be described but briefly. The sample of gas is drawn into the burette *c* by turning cocks *d* and *e* to connect with *f*, the point where the sample communicates with the apparatus. Stopcock *d* is then turned to connect with the compensator of Peterssen type, modified by Gregg[2], as shown in the drawing, Fig. 1. By raising or lowering the leveling bulb the mercury in the compensator makes contact with the platinum wire and lights the lamp *L*. The volume of gas is then read, *d* and *e* are turned to connect with the Orsat apparatus, and the carbon dioxide, unsaturated hydrocarbons and oxygen are removed successively by passing the gas into the pipettes *k*, *l* and *m*, respec-

*Published by permission of the Director of the Bureau of Mines.

†Assistant physical chemist, Bureau of Mines.

‡Junior chemist, Bureau of Mines.

[1]Burrell, G. A., and Oberfell, G. G.: "The Use of Copper Oxide for Fractionation, Combustion of Hydrogen and Carbon Monoxide in Gas Mixtures"; *J. Ind. Eng. Chem.*, vol. 8, 1916, p. 228.

[2]Gregg, E. T., "An Improved Compensator for Gas Analysis"; *J. Ind. Eng. Chem.*, vol. 9, 1918, p. 528.

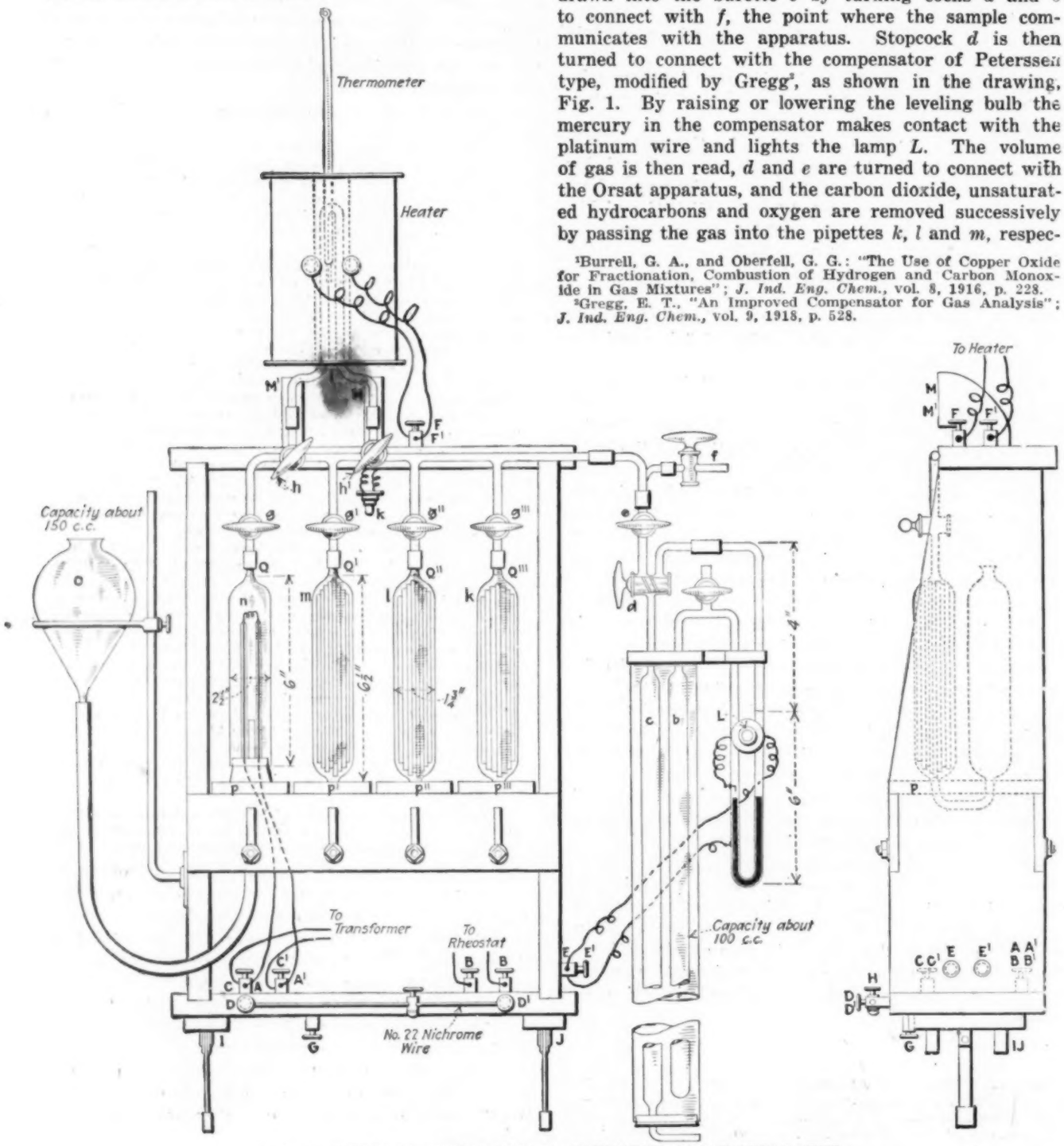


FIG. 1. GENERAL ELEVATION OF IMPROVED ORSAT APPARATUS

tively containing potassium hydroxide solution, fuming sulphuric acid and sodium pyrogallate solution. The contraction is read after passing into each reagent, by the usual method of compensation.

At the beginning of the analysis electrical connections to the heater are closed and all series resistance cut out so as to raise the temperature quickly to the desired point. The heater will reach 300 deg. C. in about the time it takes to reach the point in the analysis where hydrogen and carbon monoxide are removed. The heater is next lowered over the copper oxide tube and rests on the supports *M, M'*. The gas is passed slowly from the burette through the copper oxide tube and down into the combustion pipette *n* by way of the stopcocks *h, h'* and *g*. The flow of gas is regulated by a pinch clamp to a rate of about 10 cc. per min. Three passes each way are usually sufficient. The heater is then raised and the copper oxide tube is cooled by a compressed air blast to room temperature. The mercury in *n* is brought up to the mark *Q* and the contraction read. This contraction equals the hydrogen in the sample.

Then the gas is passed into the potassium hydroxide solution in pipette *k* several times and once through the copper oxide tube to sweep out the remaining carbon dioxide. This resulting contraction equals carbon monoxide.

The residual gas is then stored in the potassium hydroxide pipette *k* and a definite volume of oxygen drawn into the burette and measured, the amount depending upon the gas being analyzed. Should this be a natural gas, and 30 cc. of residual gas be present, about 100 cc. of oxygen will be necessary. After having measured the oxygen, it is passed through the copper oxide tube and thence into the combustion pipette *n* and stored at atmospheric pressure by adjusting the leveling bulb *O*. Stopcock *g* is now closed and the gas in the potassium hydroxide solution is drawn back into the burette *C*. The platinum wire in *n* is connected electrically through the transformer and the nichrome resistance wire *DD'*, as will be

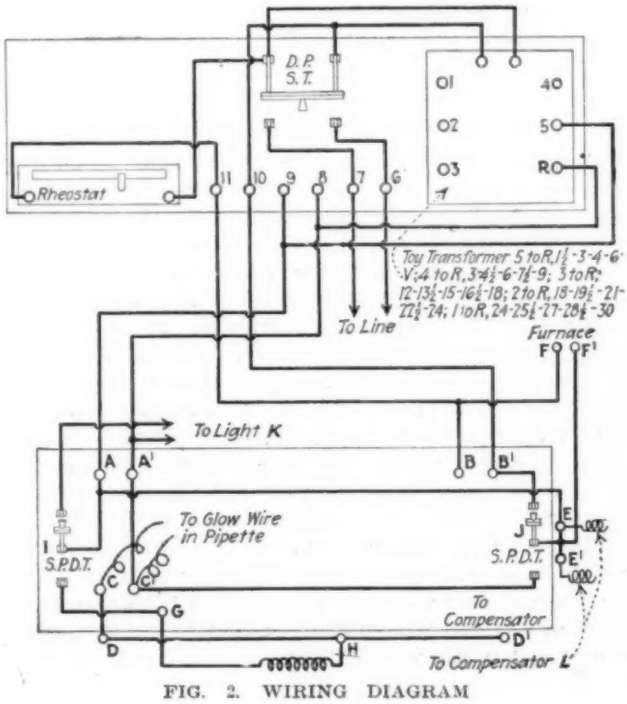


FIG. 2. WIRING DIAGRAM

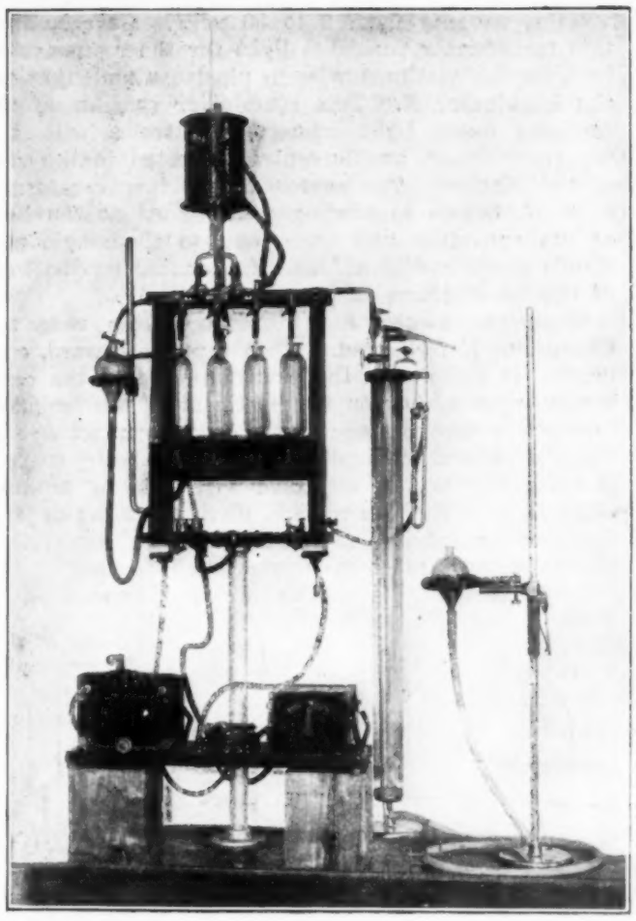


FIG. 3. ASSEMBLED GAS ANALYSIS SET

more fully explained later, and raised to a desired temperature by means of the sliding contact *H*. The flow of gas is regulated by a pinch clamp and is fed in very slowly to prevent explosions. It is passed directly into the combustion pipette without going through the copper oxide tube. A cooling blast of compressed air is played upon the pipette to prevent breaking. After the gas is completely burned, the electric current is broken and pipette *n* cooled to room temperature, the gas is drawn back into the burette *c* and read, then passed into the potassium hydroxide solution and read again, then burned a second time to insure complete combustion, measured, and passed into the potassium hydroxide again and read. From the figures for total contraction and carbon dioxide produced, the two predominating hydrocarbons present can be calculated by the usual formulas. Nitrogen is always determined by difference.

This is the general procedure for analyzing gases containing carbon dioxide, unsaturated hydrocarbons, oxygen, nitrogen, carbon monoxide, hydrogen, methane and ethane, or for gases containing part of the above constituents as natural gases.

Electrical Connections

The source of current used is 110 volts a.c. A toy transformer and a lever type resistance box are both mounted as a unit as shown in the wiring diagram, Fig. 2. Current from the mains enters the binding posts 7, 6, thence to the switch marked *D.P.S.T.* Here the current branches, part going to a toy transformer of 150-watt capacity and having a variable

voltage, ranging from 2 to 30 volts. Current from this transformer furnishes light for the compensator, heat for the platinum wire in pipette *n* and light for the illuminator *K*. This illuminator consists of the ordinary 6-volt light connected in series with the toy transformer, and is centrally located in the rear of the pipettes. The current leaves the transformer at 5, *R*, thence to binding posts *A A'* at the base of the apparatus and from here to the single pole double throw switches *I* and *J*, mounted on the base of the Orsat frame in Fig. 3.

When the switch *I* is thrown to the rear the illuminator *K* is lighted. When thrown forward, connection is made with the platinum wire in the combustion pipette. A rough adjustment of the temperature of the wire is made by the sliding contact on the transformer and the final adjustment by sliding contact *H* along the No. 22 nichrome wire held by binding posts *D*, *D'*. By this method platinum wires of any diameter or length can be used in the combustion pipette without much trouble of readjustment.

When switch *J* is thrown forward, connection is made with the compensator *L*, and when to the rear, with the heater for the copper oxide tube. In this manner the switches are easily accessible by the analyst and low voltage current is used for all but the heater.

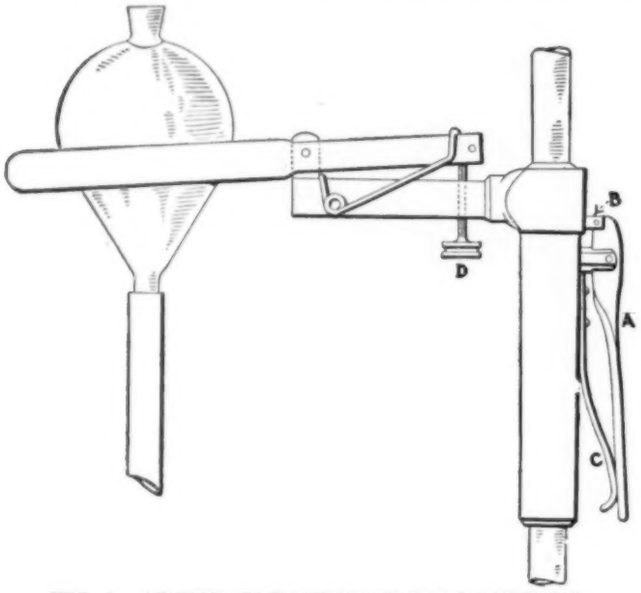


FIG. 4. ADJUSTABLE MERCURY BULB SUPPORT

The copper oxide tube heater, using 110 a.c., is made by taking 40 ft. of No. 22 nichrome wire and winding in the form of a helix. This in turn is wound over a collapsible wooden mandrel protected by a layer of asbestos paper. After the helix of nichrome wire is evenly adjusted over the mandrel, a mixture of calcined magnesium oxide and sodium silicate is made into a thick paste. Thorough mixing in a mortar and using well-calcined magnesium oxide is very necessary; otherwise the furnace will crumble after being in use for a short time. This paste is worked in very carefully between the coils of wire, then wound with a layer of asbestos rope, more paste, asbestos rope and so on until the walls are at least ½ in. thick. The heater is then covered with asbestos paper, the ends protected with "transite" boards and the terminals of the coils drawn out through the asbestos paper and "transite" board and fastened with binding posts. The furnace is then dried for several hours at 100 deg. C., after which it is ready for use.

Pipette Supports

All the pipettes are supported by adjustable brackets *p*, so that pipettes of any length can be used, or easily removed for cleaning or renewal of reagents.

Fig. 4 shows a device for raising and lowering the mercury bulb connected with the gas burette. By exerting pressure on the lever *A* with the hand, the friction pin *B* is released from the rod supporting the bulb, when the support can be raised or lowered at will. When the pressure is removed spring *C* forces the friction pin *B* into contact with the supporting rod and holds the bulb firmly at that elevation. Final adjustment is made by turning setscrew *D* with the thumb and forefinger, thus raising and lowering the bulb only a very small distance. In making an analysis the solution in the pipette is brought approximately to the correct point when the bulb is clamped and the solution brought exactly to the mark by final adjustment with the setscrew *D*.

It has been suggested that quartz should be used for the copper oxide tube and combustion pipette. The Bureau has had copper oxide tubes and combustion pipettes made of pyrex glass in steady use for over two years without breaking. It is understood that when burning the gas must be fed into the oxygen instead of the oxygen into the gas, also that the pipette must be kept cool by compressed air or by some other means, when burning gases containing a large amount of combustibles—especially those of high molecular weight like ethane and propane.

Copper oxide is hydroscopic, and when an apparatus has not been used for some time it is necessary to give the tube a preliminary treatment by passing air through it for some time at a low temperature in order to drive out the moisture. When the copper oxide has become somewhat reduced, which is indicated by the red color, compressed air or oxygen is passed over the mass heated to a temperature of about 250 deg. C. to revive it.

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Pittsburgh, Pa.

Improvement in Sheet-Ground Region

A marked revival in zinc production in the environs of Miami, Oklahoma, has occurred since the low-price level attained in July, when only about 85 properties were able to produce at the then ruling price of about $35. Perhaps half as many mills have resumed, in response to an increase in price of zinc concentrates to $55, which is regarded as being about as much as the present spelter market can carry. Shortage of labor and prospecting rig helpers has prevented a large expansion in tonnage, however, many men having gone into the harvest fields or the Texas oil regions. While a good shoveler working "by the can" earns $1 an hour, mill men and mechanics have not enjoyed a correspondingly fancy rate. The operators feel that lower costs of living are necessary in order that their employees may be satisfied and labor stabilized, and a fuller resumption of business activities in the United States before the lead and zinc industry, either in the production of mineral or the manufacture of metal, can assume a healthy and profitable condition.

Radiant Resistor Furnace*

The Author Describes His Radiant Resistor Furnace for the Distillation of Low-Grade or Scrap Zinc—Best Results Obtained With a Current of Approximately 845 Amp. at 65 Volts or 55 Kw.—With This Power the Output Was About 50 Kg. Refined Zinc Per Hour

BY F. A. J. FITZ GERALD†

IN 1905 a small laboratory furnace in which the charge was heated by means of radiant resistor was described.[1] A note about a furnace heated in a similar manner, but having an electrical capacity of 150 kw. was published in 1910,[2] and the description of another design appeared under the title of "A New Electric Resistance Furnace," in a paper given to the American Electrochemical Society in 1911.[3] This also had a capacity of 150 kw., and, like the furnace described in 1910, was designed by Thomson and Fitz-Gerald, the object in each case being the smelting of zinc ores by the Imbert process. The furnace described in 1911 was used in experimental work and was found to be very unsatisfactory, as shown in a paper, "Note on an Unsuccessful Furnace Experiment," presented to the American Electrochemical Society in 1911,[4] but the experiments showed very clearly that the trouble was due to faulty design and construction, more particularly very imperfect heat regulation.

In 1915 the cost of high-grade zinc increased so much that experiments on the distillation of low-grade or scrap zinc appeared to be worth while, therefore Thomson, with our collaboration, designed a furnace on principles similar to those mentioned above, and this was built and operated at the FitzGerald Laboratories, several tons of refined zinc being produced.

The diagrams of Figs. 1, 2 and 3 show the construction of the furnace; Fig. 1 with the cover removed, Fig. 2 a longitudinal vertical section, and Fig. 3 a transverse vertical section. The furnace was approximately 2 meters long (6½ ft.) and the diagrams are drawn approximately to scale. The same lettering is used in all figures.

The parts of the furnace constructed of firebrick are marked *D*, and the heat insulation, which consisted of either Sil-O-Cel or the insulating brick made by the Armstrong Cork Co., is marked *A*. The furnace hearth containing the charge was made of various materials, *L*, but the most satisfactory was a carbonaceous refractory called "Vitricarbo" manufactured by the National Carbon Co. The furnace was heated by two resistors, *R*, which were made from graphite slabs which had slots cut into them so as greatly to increase the path of the current. The current is brought to the resistors by the graphite terminals *T T* and the resistors are connected in series by the graphite connector *T'*. The furnace was charged with molten zinc by means of the inclined tube *S*, the lower end of which was normally below the surface of the molten bath. Above the resistor were two diaphragms *B*. The lower one of these consisted of a set of plates laid transversely in the furnaces, each plate being one inch distant from its neighbors, thus forming a porous diaphragm. The upper diaphragm was made of 2-in. (5-cm.) carbon slabs, and it did not extend to the ends of the furnace. Thus the zinc vapors had to pass up first through the openings in the lower diaphragm and thence flowed out round the ends of the upper diaphragm, finally reaching the opening *F*, which led to the condenser. The cover of the furnace was formed of carbon slabs *C*, on top of which were the firebrick *D* and finally the heat insulating brick *A*. At *O* there was a hole in the cover into which a pyrometer tube was inserted for measuring the temperature of the zinc vapors passing into the condenser through *F*. The condenser is not shown in the diagram, but was in the form of a flat box about 100 x 50 x 7 cm. with a series of transverse baffle plates. This was provided with means for preheating, at first electrically but subsequently with a charcoal fire, since once distillation was fairly under way external heating was unnecessary.

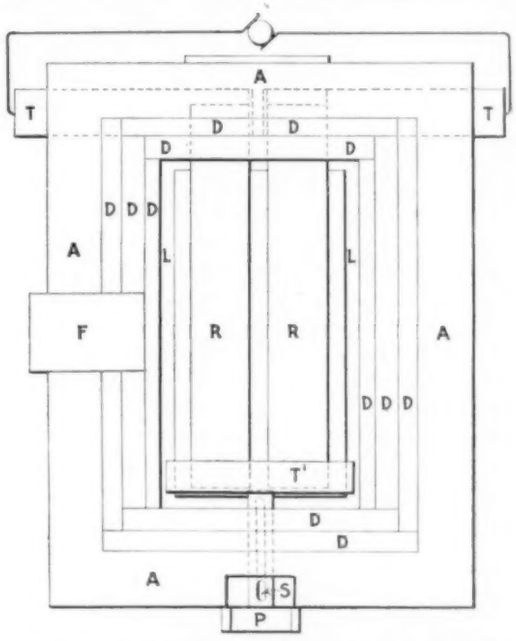


FIG. 1. FURNACE WITH COVER REMOVED

The furnace was originally designed with the idea that it would use 75 kw. or 1000 amp. at 75 volts, and turn out 45 kg. of zinc per hour. It was found, however, that the best results were obtained with a current of approximately 845 amp. at 65 volts or 55 kw., and that with this power the output of distilled zinc was about 50 kg. per hour.

From previous experimental work with zinc furnaces much experience had been gained in the problem of condensing zinc vapor, so that no difficulty was found in

*Paper read at the meeting of the American Electrochemical Society in Chicago, Sept. 23-26, 1919.

†Electric furnace expert, Niagara Falls, N. Y.

[1] *Electrochemical & Metallurgical Industry*, vol. 3, p. 218 (Now consolidated with CHEM. & MET. ENG.)

[2] MET & CHEM. ENG., vol. 8, p. 317.

[3] *Transactions* (1911) vol. 19, p. 273, *et seq.*

[4] *Transactions* (1911) vol. 20, p. 281, *et seq.*

designing a condenser which would give liquid zinc without the production of any **blue powder.** There were plenty of other troubles with the condensers, mainly due to the difficulty of constructing the particular form used in such a way that it would not develop leaks. These difficulties were, however, overcome.

The method of working the furnace was as follows: When building it, before putting in the resistors, as much scrap or low-grade zinc was put into the hearth *L* as it could contain, and the construction of the furnace then finished. After starting, the current was at first kept very small so as to dry out the furnace

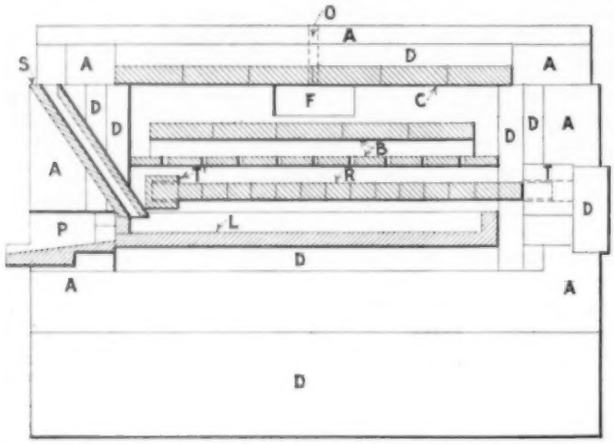


FIG. 2. LONGITUDINAL VERTICAL SECTION OF FURNACE

slowly, then it was raised and more zinc from the premelter introduced through *S* until the lower end of *S* was well closed. Meanwhile the condenser was heated to a temperature slightly above the melting point of zinc. When the zinc vapor began distilling, the temperature in the condenser rose till finally it was no longer necessary to supply external heat, but instead some of the heat insulation was removed. Thereafter it was merely necessary to keep a watch on the condenser temperature and slightly adjust the air-cooling devices. The zinc was tapped from the condenser at intervals, and premelted zinc introduced so as to keep

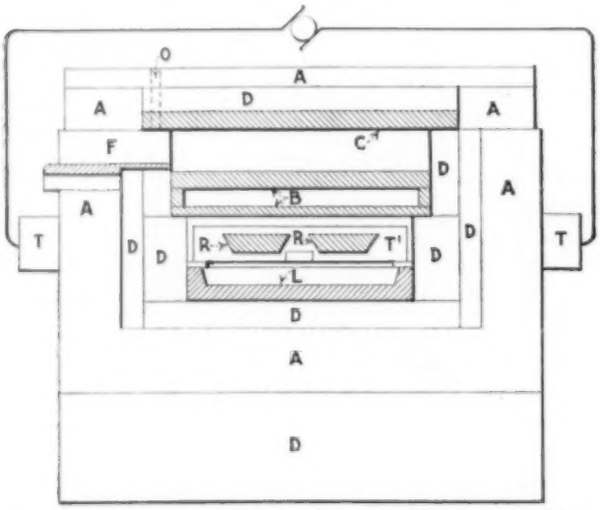


FIG. 3. TRANSVERSE VERTICAL SECTION OF FURNACE

the lower end of the tube *S* closed. From time to time the residue in the furnace, consisting mainly of zinc very high in iron and lead, was tapped from the furnace at *P*.

One interesting accident which happened once or twice was the plugging up of the charging tube *S* caused by pouring in molten zinc too near its freezing point. This was cleared by making electrical contact with the bath through the tap hole at *P* and then arcing on the frozen zinc with a rod introduced through *S*.

The experimental work on the distillation of zinc ran over many months, for all sorts of investigations were made on forms of resistors, designs of terminals, various kinds of premelting furnaces, small-scale experiments on fractional distillation of zinc alloys, production of blue powder, various forms of condensers, refractory materials, heat insulators, etc. But to give an idea of the furnace's working under normal conditions, a run of 37 hours may be taken, because this will show the behavior of the furnace after starting up and also what may be expected from it with continuous running under constant conditions. Energy measurements were made at the furnace. The zinc charged into it was in the molten state, hence the figures for energy consumption do not include melting. Here are the data obtained:

Length of run	37 hr.
Average power used during distillation	55.2 kw.
Total energy for distillation	2051 kw.-hr.
Minimum temperature of zinc entering condenser	1040 deg. C.
Average temperature of zinc entering condenser	1225 deg. C.
Average temperature of zinc in premelter	550 deg. C.
Weight of zinc condensed	1558 kg. (3494 lb.)
Weight of zinc condensed per hr.	43 kg. (95 lb.)
Energy per kg. of zinc	1.29 kw.-hr.
Energy per lb. of zinc	0.59 kw.-hr.

In order to get a notion of the behavior of the furnace when it has reached normal working conditions the last 9 hr. of the run may be taken:

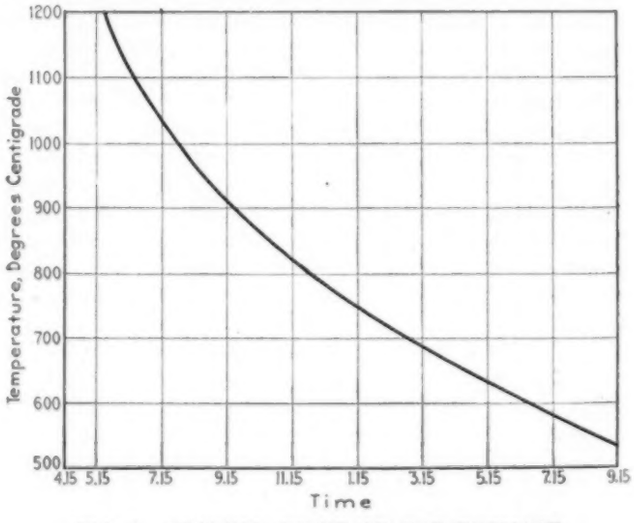


FIG. 4. COOLING CURVE OF THE FURNACE

Length of period	8.9 hr.
Average power used during distillation	54.4 kw.
Total energy for distillation	484 kw.-hr.
Av. temperature of zinc vapor entering condenser	1250 deg. C.
Average temperature of zinc in premelter	550 deg. C.
Weight of zinc condensed	455 kg. (1001 lb.)
Weight of zinc condensed per hr.	51 kg. (112 lb.)
Energy per kg. of zinc	1.06 kw.-hr.
Energy per lb. of zinc	0.48 kw.-hr.

A question that will naturally be asked is how much energy was used in premelting the zinc fed into the furnace. Unfortunately the records do not give a direct answer to this question, for much trouble was experienced with the premelter during the earlier part of the run. However, it is possible to get a fairly close approximation of what energy we used for premelting during the last 9 hr. of the run from the following data:

Weight of zinc melted.....968 kg. (2130 lb.)
Energy consumed for melting.....216 kw.-hr.
Energy per kg. of zinc.....0.22 kw.-hr.
Energy per lb. of zinc.....0.10 kw.-hr.
Weight of zinc transferred from melter to furnace, 632 kg. (1390 lb.)
Energy used to melt 632 kg. of zinc.....139 kw.-hr.

Now, by referring to the figures given above for the last part of the distillation, it is found that the total energy used in producing 455 kg. (1001 lb.) of distilled zinc was 623 kw.-hr., hence:

Total energy per kg. of zinc.....1.37 kw.-hr.
Total energy per lb. of zinc.....0.62 kw.-hr.

It will be observed from these figures that the percentage of zinc refined by distillation in this particular experiment was only 72 per cent of the amount charged, therefore the amount of zinc which had to be premelted was greater than would have been the case had the distillation been carried further.

The curve shown in Fig. 4 is a cooling curve of the furnace.

As regards furnace troubles, the only one that amounted to anything was leaking of the hearth. This was simply due to faulty construction of the lining, a fault that was corrected by experience.

Tungsten Situation in Peru

PRACTICALLY all the tungsten ore exported from Peru is produced in the districts of Conchucos and Corongo, both situated back of the ports of Salaverry and Chimbote, the mineral being transported over the mountains on the backs of llamas and burros from the tungsten mines to the railways connecting with these two ports. Practically all mining of tungsten is done in a very primitive manner. The miners are the Indians—what are commonly known here as "cholos"—of the mountain districts. The mineral is all hand washed by the Indians.

The mining of tungsten in Peru may be considered sporadic; that is, its development depends largely upon the demand and prevailing prices in Liverpool and New York. When the price of the ore is low, little interest is manifested in its mining, and the Indians are withdrawn from the tungsten mines or holes to be occupied in the copper and silver producing mines in the same district. Fortunately during the last four years there has been a good demand for tungsten, which has favorably affected the industry.

Destination of Exports

The exportation of tungsten ores from Peru during the years 1913 to 1917, with the ports of shipment, quantity and value exported, and the countries of destination, is given in Table I. It will be noted that the average exports of tungsten during the last five years are about 354 metric tons a year. Prior to the war about 60 per cent of all tungsten exported from Peru went to Germany. Since the middle of 1914 the exports have been diverted to the United States, a small quantity finding its way to Great Britain and France.

The total exportation of tungsten from all Peruvian ports to New York during the calendar year 1918, showing the points of shipment, quantity and net value, is given in Table II. The mineral shown as shipped from Callao originally came from the port of Chimbote, and that recorded as shipped from Mollendo originated in Bolivia, from which country considerable quantities are exported to the United States and some European countries.

TABLE I. EXPORTATION OF TUNGSTEN ORES FROM PERU, 1913–1917

Port of Shipment	Quantity Kilos	Value	Country of Destination	Quantity, Kilos	Value
1913					
Chimbote	122,466	$36,397	Germany	151,636	$45,672
Salaverry	167,836	56,919	United States	117,469	40,701
			France	8,367	2,501
			Great Britain	12,830	4,442
Total	290,302	93,316	Total	290,302	93,316
1914					
Callao	2,940	1,395	Germany	122,508	61,831
Chimbote	71,613	34,144	United States	9,068	4,666
Salaverry	121,713	62,250	France	1,750	849
Not specified	.....	63	Great Britain	26,047	12,793
			Italy	36,893	17,713
Total	196,266	97,852	Total	196,266	97,852
1915					
Callao	15,902	13,698	United States	288,527	209,857
Salaverry	177,266	134,224	France	7,802	8,039
Chimbote	145,965	101,581	Great Britain	42,804	31,607
Total	339,133	249,503	Total	339,133	249,503
1916					
Callao	9,688	12,472	Bolivia	200	484
Chimbote	188,612	421,977	United States	517,252	1,066,507
Puno	300	484	France	6,380	5,889
Salaverry	325,332	637,947	.....	.....	.....
Total	523,932	1,072,880	Total	523,832	1,072,880
1917					
Callao	1,286	1,155	United States	417,336	485,016
Chimbote	152,698	182,446	.....	.....	.....
Salaverry	263,352	301,415	.....	.....	.....
Total	417,336	485,016	Total	417,336	485,016

TABLE II—EXPORTS OF TUNGSTEN FROM PERU TO NEW YORK, 1918

Port of Shipment	Gross Weight, Kilos	Net Weight, Kilos	Tungsten Contained, Kilos	Commercial Value	Freight Value	Net Value
Salaverry	178,959	176,487	109,860.6	$243,812	$19,742	$224,070
Chimbote	55,669	54,885	33,439.2	74,206	4,102	70,104
Callao	11,030	10,780	7,478.2	16,595	907	15,688
Mollendo	904	891	534.6	1,186	43	1,143
Total	246,562	243,043	151,312.6	$335,799	$24,795	$311,004

Cost of Production and Price Quotations

It is difficult to ascertain the cost of the production of tungsten delivered at the coast, as it depends upon the distance the ore is transported by llamas and burros, the proximity of the mines to the railways, and the wages paid. However, the cost of mining and delivering the concentrates at the seacoast should be insignificant in comparison with the prices received during the war for the ore, particularly when it is known that the average Indian miner works for about $1 a day. The price received for the ore is regulated by the prevailing price of the mineral markets of Liverpool and New York. Tungsten is shipped in concentrates of from 58 to 60 per cent. The owners of the mineral in Peru generally arrange with the buyers to draw against each shipment up to 70 per cent of its value.

The price of tungsten in June, 1919, was about $10 a unit of 60 per cent concentrates. Before the war it was about $7; during the war the price reached the maximum of $26 a unit.

War Department Record of Government Purchases During War

Mr. W. L. Pollard, chief of the Historical Branch of the Purchase, Traffic and Storage Division of the War Department, is sending out a questionnaire to all firms which have supplied the U. S. Government during the war. This document covers the nature, value and quantity of materials and details of production, together with new processes, changes in operation, amount of capital investments added, labor difficulties, replacement by female labor, and other data necessary to obtain complete record of accomplishments of this branch of the country's activity.

Substitute Metals in Electrotechnical Industries in Germany*

THE most important of these substitutions is the use of aluminum in manufactures formerly made of copper. Before the war it was almost universal practice in Germany to use exclusively copper for bodies which had to conduct electric current. Germany used before the war about 200,000 tons of copper per year, not including copper exported in finished articles. Of this quantity, scarcely 10 per cent was furnished by her own mines.

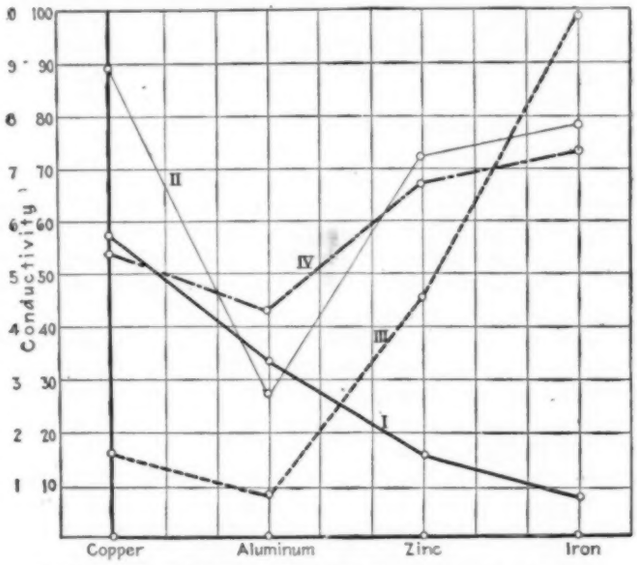
At the beginning of the war very great quantities of copper were used for munitions, submarine boat motors, and other important war material; at the end of 1914 the necessity of substitutes for the fast-vanishing supply of copper was clearly seen. The principal substitutes are iron, zinc and aluminum, all of which have lower electrical conductivity than copper; therefore, to avoid great losses of electric energy, larger cross-sections must be used, entailing greater cost of metal and of construction to support it.

The accompanying diagram gives at a glance the relative values and usefulness of copper, aluminum, zinc and iron as electrical conductors. Line I shows the relative electrical conductivity of the four metals. Line II shows the specific gravities. Line III shows the relative weights of metal necessary to use for a conductor of a given length in order to get equal current carrying power (conductance); these ordinates are made proportional to I divided by II. If the points on line III are multiplied by the price of the metal per kilo, line IV results, which shows the relative costs of lines of equal length and the same conductance, at present prices for plain wire or rod metal. It is seen that aluminum needs to be only about one-half the weight of copper, and costs, at present prices, about four-fifths as much. These relations will change with the market prices. While the conductivity is one of the most important characteristics to be considered in this comparison, it is not the only one which influences the use of these metals for electrical conductors.

Iron has the advantage of great mechanical strength, which gives it many advantages for suspended freely-hanging conductors. Its conductivity is so small, however, that its strength can be of importance only where electrical energy losses are of secondary importance. A still more important question is the magnetic qualities of iron, which frequently forbid its employment in machines, and cause too great losses by the energy consumed in magnetizing and de-magnetizing it, where alternating current or pulsating direct current is used. Iron was therefore used during the war in a very few places for conducting the current, such as in relatively short high-tension lines, in some special switches for small amperage, and for collector brushes on small direct-current machines. In the future almost all these will be replaced by copper or aluminum, with perhaps the possible exception of the above-mentioned short high-tension lines as long as these are used as branch lines to separate consumers and are not in the circuit of the principal line.

*Abstracted from *Das Technische Blatt*, May 3, 1919, p. 24. A. Feckinghaus, "Ersatzstoffe in der Elektrotechnischen Industrie."

Zinc was much spoken of as a substitute metal in the early days of the war. It has very little mechanical strength, and therefore is unsuited for freely-suspended conductors or similar purposes. Zinc wire insulated with rubber and cotton was quickly put to use as installed conductors in buildings, for light and power purposes. Attempts were made to alloy it, in order to increase its mechanical strength, but it was found that only the purest zinc would stand the requirements necessary for installing such wire in buildings. After overcoming these difficulties, many thousand kilometers of such wire was laid, without any difficulties arising which could be ascribed to the zinc. In such use it must be observed that the zinc is not installed at low temperatures, say under 5 deg. C. (40 deg. F.), that it will not stand high temperatures, such as 80 to 100 deg. C. (176-212 deg. F.), and must not be subjected to any continuous vibration. Under such adverse conditions it becomes brittle, crystallizes and forms a discontinuous mass which cannot carry the current. At first zinc was also used for windings of dynamos, transformers, coils for various apparatus, etc., and apparently with success, but difficulties arose



RELATIVE VALUES AND USEFULNESS OF COPPER, ALUMINUM, ZINC AND IRON AS ELECTRICAL CONDUCTORS

I. Relative electrical conductivity. II. Specific gravities. III. Conductance. IV. Product of conductance and price of metal per kilogram.

so frequently, because of the above-noted properties, that even during the course of the war such applications were given up. On a large scale, zinc is now used only in insulated installed wiring, but even this use will probably be abandoned to copper or aluminum.

Aluminum is the metal which has mostly replaced copper during the war, and which will stand alongside of copper in the future. In this replacement, however, other questions than the specific properties of aluminum must be considered. At the beginning of the war there was no aluminum works in Germany and only imported aluminum ingots were available. This crude metal came from Switzerland, which in turn obtained the aluminum oxide or alumina, from which the metal is extracted, from France. During the first part of the war the Germans were able to obtain all the aluminum required, but later the supply diminished so that they felt the necessity of

building their own reduction plants. This became the more practicable since meanwhile alumina was being manufactured in Austria, Galicia and even in Germany, thus providing the raw material for the industry. The cost of production was immaterial, since the metal had to be made as a war necessity. Switzerland, with its cheap water power, could naturally produce cheaper, but the large amount of power necessary had to be found in Germany. The plants were therefore placed near the fields of brown coal (lignite), which is a relatively cheap fuel, useful alike for manufacturing alumina from the raw minerals and for raising steam to provide the power necessary for the electrical reduction of the alumina to metal. Today the German output of aluminum is already important, although the works are not yet all completed. It is naturally of the greatest importance for Germany to reduce as far as possible its need of importing copper, and to produce its substitute, aluminum, from German raw materials in German factories. It is estimated that it will be possible for them thus to shut off permanently one-third of the former importations of copper, corresponding to a value of several hundred million marks yearly. But since enormous stocks of copper have accumulated in America, which after the war will be dumped on the German market at low prices, it will be necessary that their domestic aluminum works be able to compete with cheap American copper.

Although aluminum has only one-third to one-fourth[1] the mechanical strength of copper, yet it is strong enough to be used extensively in all kinds of bare conductors. Its use as insulated wire installed in buildings has already been alluded to. It is also used in lead-covered cables which are buried in the ground, particularly for the smaller cross-sections. Three-phase motors and transformers, excepting the quite small types, are exclusively provided with aluminum windings. Direct-current motors have aluminum magnet-windings; it is also used in collectors and a large number of apparatus, instruments and installation equipment.

A difficulty is produced in some places by the layer of oxide which forms on aluminum, a thin film of aluminum, which gives poor contact at the binding posts. It can also not be welded or soldered easily. Special methods are therefore used to make secure and durable contacts or joints, but these are not sufficiently simple to enable aluminum in all cases to replace the much more easily soldered copper. The armature windings of direct-current generators, for instance, have been made of aluminum, but more recently the makers have returned to using copper, since the many connections of the armature coils to the collector sheets give trouble.

New Rules for the Use of Metals

The German Electrotechnical Union has recently set forth new rules concerning the use of copper, aluminum, etc., based on experience collected during the war; these rules must be observed, under penalty. According to these rules, the above-mentioned uses of aluminum are, for the greater part, to be continued, since experience has shown that this can be done without detriment to the quality of the manufactured object. A large part of the purchasers of electrical equipment have still a certain mistrust concerning the use of aluminum, for instance in three-phase transformers and motors, and insist on having only copper. For this reason, ten and twenty-year-old machines are being sold at extraordinarily high prices simply and only because they are wound with copper. This fact tends to increase the mistrust of the purchasing public against aluminum, which sentiment is skillfully nurtured by the people having such old machines to sell, in order to obtain still higher prices. But the quality of the machines now being made with aluminum is so high that this prejudice is certain to subside and the general use of aluminum for such purposes may be taken as certain, since it is in reality a complete and satisfactory substitute.

The war has therefore been fruitful to the electrotechnical industries of Germany, in that it has taught by sheer necessity how to manufacture as independently as possible of importations from foreign countries, and using only the domestic raw materials. The commercial balance sheet will thus gain a permanent advantage.

[1] It is stronger than stated, up to two-thirds to three-fourths.—Abstractor.

The Proposed Belgian Steel Trust

The proposed Belgian steel plant combination is discussed by the London *Iron and Coal Trades Review*. The origin of the scheme is attributed to M. Trasenster, general director of the Ougrée-Marihaye Co., who recently invited representatives of the works to attend a meeting to consider the scheme. The works represented were the Cockerill Co., Thy-le-Château, Sambre and Moselle, Angleur, Espérance Longdoz, Athus-Grivegnée, Usines Métallurgiques du Hainaut, Monceau Saint-Fiacre, Forges de Clabecq, La Providence, Châtelineau and Boel. The meeting is reported to have approved the plan in principle, although two of the most important works are said to have hitherto held aloof.

The proposition is that the combination should take over the assets and liabilities of the constituents, and that the share capital of 300,000 francs be allotted to the works in proportion of the respective values of their undertakings. In order to reach a basis of valuation a meeting of the financial representatives of the works has just been held at the Société Générale, Brussels. After discussion the following points were agreed to as the basis: Ascertainment of the stock exchange value of the shares on June 30, 1914, ascertainment of the profits in the 30 months immediately preceding July 31, 1914, and inventory of the buildings, mine fields, materials, etc. In this connection the representatives of the Ougrée and Providence companies stated that it was impossible at present to ascertain the future value of the iron-ore mines and their investments in mines which they possess in Luxemburg and France, and the Angleur company associated itself with this objection. The three companies, however, eventually agreed that the value of their iron-ore rights should be determined by experts.

The managing director of the Ougrée-Marihaye Co. stated recently that, if the amalgamation was carried out, each works would specialize in the product for which it was best adapted and thus be in a position to lower the producing costs and selling prices without lessening the profits.

Recent Chemical and Metallurgical Patents

British Patents

Complete specifications of any British patents may be obtained by remitting 25c. each to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Sulphonic Acids.—Sulphonic acids are isolated from crude sulphonation products in the form of salts of divalent or trivalent metals, such as magnesium, aluminum, iron, nickel, cobalt, cadmium, or zinc, by adding to the crude product a soluble sulphate of such metal in amount not exceeding 5 per cent in excess of the theoretical amount for double decomposition, the strength of the sulphuric acid in the mixture being maintained throughout at 30 to 50 per cent; the precipitated salt is filtered and washed with a cold saturated solution of the sulphonic acid salt obtained in the previous operation; part of the filtrate is neutralized with metal, oxide, hydroxide, or carbonate, and used to provide the metallic salt for the next operation, while the rest constitutes recovered sulphuric acid. The process may be applied to the separation of two or more mixed sulphonic acids obtained by sulphonation. Examples are given of the isolation of benzene sulphonic acid as magnesium salt, the separation of phenol-p-sulphonic acid as zinc salt, and the separation of m-xylenesulphonic acid as magnesium salt. (British Patent 14402—1915. A. LAPWORTH and H. N. MORRIS, both in Manchester; May 14, 1919.)

Explosives.—Methods of preparing explosives which consist in the use of dicyandiamidine perchlorate alone or mixed with other ingredients as blasting and military explosives and in methods of manufacturing the dicyandiamidine perchlorate. One example of such explosives contains dicandiamidine perchlorate 69 per cent, sodium nitrate 29 per cent and wood meal 2 per cent. Another example contains dicyandiamidine perchlorate 10 per cent, trinitrotoluene 10 per cent, and ammonium nitrate 80 per cent. One method of manufacturing dicyandiamidine perchlorate is to convert dicyandiamide into dicyandiamidine sulphate, and then add to a solution of this a solution of barium, strontium or calcium perchlorate. Another method of manufacturing is to convert dicyandiamide into dicyandiamidine hydrochloride by heating with hydrochloric acid, and then add a hot concentrated solution of sodium perchlorate; this reaction also takes place at ordinary temperatures. (British Patent 14706—1915. W. RINTOUL, E. G. BECKETT and NOBEL'S E PLOSIVES CO., Ardeer factory, Stevenston, Ayrshire; May 14, 1919.)

Explosives.—Method of making explosives by adding 82 parts of ammonium perchlorate or 83½ parts of potassium perchlorate to about 18 or 16½ parts respectively of melted paraffine wax. After cooling, the mixture may be pressed into any shape desired or may be used in the form of powder or granules. (British Patent 14932—1915. PERCHLORATE SAFETY E PLOSIVES, LTD., and H. HARRIS, London; May 14, 1919.)

Explosives.—Method of making explosives by mixing ammonia perchlorate with calcium or barium silicide, to which may be added sodium or potassium nitrate and other ingredients such as paraffine wax, wood meal and aromatic nitrohydrocarbons, for example trinitrotoluene. An example contains 75 per cent of ammonium perchlorate, 15 per cent of calcium silicide, and 10 per cent of paraffine wax. (British Patent 10865—1915. E. I. PRONK and F. E. W. BOWEN, both in London; May 14, 1919.)

Cracking Hydrocarbons.—High boiling hydrocarbon oils and residues are converted into low boiling hydrocarbon by bringing them in the liquid state into contact with pumice stone or sandstone heated to 500-800 deg. C. in a closed retort, and condensing the resulting vapors. The vapors are removed by a pump and are fractionally condensed under pressure, for example 16 atmospheres. Viscous hydrocarbons, such as tars, are preheated to increase their fluidity. In treating tar for the production of toluol, a temperature of 750 deg. C. is employed. Liquid fuel of the nature of petrol is produced from fuel oil at about 550 deg. C. (British Patent 10981—1915. J. G. ROBERTSON, Partick; and J. NILSON and PETROL PATENTS, LTD., Glasgow; May 14, 1919.)

Ketones.—Acetone and di-ethylketone are prepared by passing the vapor of acetic or propionic acid over manganous oxide at about 350 deg. C. The manganous oxide is distributed or supported so as to present an extended surface and remain porous. This may be effected by boiling pumice in a solution or suspension of manganous acetate or carbonate, drying, and heating until the oxide is formed. (British Patent 14085—1915. N. V. SEDGWICK and B. LAMBERT, both in Oxford; May 14, 1919.)

American Patents

Complete specifications of any United States patents may be obtained by remitting 10c. each to the Commissioner of Patents, Washington, D. C.

Basic Sulphate of Zirconium.—It has been proposed to produce zirconium oxide by first preparing a zirconium oxychloride and treating this with a definite amount of sulphuric acid, the mixture being allowed to stand in the cold or at about 40 deg. C., when a basic sulphate of zirconium having the composition $3ZrO_2 2H_2SO_4$ separates in small prisms which are free from iron and titanium. This basic sulphate of zirconium can be converted to zirconium oxide by any well-known method. The method is, however, objectionable in that the time required for the precipitation of the basic sulphate of zirconium extends over a great number of days. Further, the precipitation is never complete, less than 75 per cent precipitating out in two weeks. EDWARD J. PUGH of Glenside, Pa., uses the following modified procedure to obtain a better yield in less time: A quantity of zirconium oxychloride containing 100 g. of zirconium oxide is dissolved in 3 liters of water; this solution is acidified with hydrochloric acid and an addition of 48 g. of sulphuric acid is made. So long as the solution remains cold, little or no precipitate is formed, but upon heating a white crystalline precipitate is formed having the composition $5ZrO_2 3SO_3 13H_2O$. The zirconium is thus precipitated as a new basic sulphate free from iron, titanium and silicon and capable of ready conversion to pure zirconium oxide in any well-known manner. (1,316,107; assigned to Pennsylvania Salt Mfg. Co.; Sept. 16, 1919.)

Cellulose Solvent.—Cellulose is soluble in mixtures of hydrochloric, sulphuric and phosphoric acids. For example: 1 kg. of air-dried cotton is kneaded with

about 6 kg. of a mixture of hydrochloric acid (35 per cent HCl) 9 parts, sulphuric acid (99 per cent) 0.5 part, and phosphoric acid (85 per cent) 2 parts, all by weight; the solution is cooled to prevent escape of HCl. A thick viscid mass results, which may be clarified and then forced through nozzles into a suitable coagulating bath, as water, dilute acids, solutions of various salts, solutions of colloids and various other media such as alcohol, etc. The solution may also be allowed to hydrolyze and the glucose thus formed may be recovered or fermented to alcohol. (1,315,393; ZENO OSTENBERG of San Jose, Calif.; Sept. 9, 1919.)

Production and Use of Aminocymene as a Dye Intermediate.—The so-called "spruce turpentine," which is a by-product from the relief liquor collected in the process of making sulphite pulp from spruce chips, contains cymene, terpenes, H_2O and dissolved SO_2. CHESTER E. ANDREWS of Pittsburgh proposes the following process for recovering and utilizing the cymene. Spruce turpentine is treated with sufficient quicklime to combine with and precipitate the H_2O and SO_2 present. After filtering, the liquid contains approximately 75 per cent cymene, the remainder being terpenes. This mixture is dissolved in 98 per cent sulphuric acid and nitrated with mixed acid at 0 deg. C. The product is poured into cold water, the oily layer separated and washed with dilute alkali solution. The principal ingredient is mononitrocymene (1-methyl-2-nitro-4-isopropylbenzene). This is easily reduced to the corresponding amino compound, which may be purified by agitating with dilute sulphuric acid, forming the sulphate of the amine. This is not volatile with steam and may thus be separated from the impurities (terpenes) by steam distillation. The sulphate is then decomposed by alkali and the pure aminocymene recovered by steam distillation. The remainder of this series of patents is devoted to a description of the various dyes which can be obtained from monoaminocymene by the following general reactions: (1) Diazotizing, followed by coupling with hydroxy or amino compounds; (2) Reduction with Zn in alkaline solution to form hydrocymene, which gives, by the benzidine reaction, dimethyl-di-isopropylbenzidine. This may be coupled with a variety of compounds. (3) Monoaminocymene and its derivatives may be mixed with aniline, nitrosophenol, aminophenols, etc., and fused with sulphur to form sulphur dyes. (1,314,920 to 1,314,929 inclusive; assigned to the Selden Co., of Pittsburgh; Sept. 2, 1919.)

Preparation of Pure Ethylene.—Ethylene may be separated from a gaseous mixture (formed, for example, by the process outlined in U.S.P. 1,315,540) by passing the gases through a neutral or acid solution of mercuric salts. In the case of mercuric sulphate, a compound having the empirical formula $HgSO_4.C_2H_4$ is formed at temperatures between 0 and 25 deg. C. The compound is decomposed on boiling the aqueous solution, yielding pure ethylene. (1,315,541; GEORGE O. CURME, JR. of Pittsburgh, assignor, by mesne assignments, to Union Carbide Co.; Sept. 9, 1919.)

Acetone From Acetic Acid.—Acetone may be prepared from acetic acid in the vapor form by passing the same through tubes or vessels containing iron in a finely divided condition, as of fine shavings, maintaining these tubes or vessels at a temperature between 550 and 600 deg. C., at which temperature a quantitative yield of acetone is obtained from the acetic acid introduced, condensing the vapors issuing from this apparatus and then preparing from the condensate, by simple rectification, the pure acetone. (1,315,544; GEORGE O. CURME, JR., of Pittsburgh, assignor, by mesne assignments, to Union Carbide Co.; Sept. 9, 1919.)

Ethylene and Propylene Dichlorides.—GEORGE O. CURME, JR., of Pittsburgh claims that chlorination of ethylene and propylene proceeds with greater ease and rapidity in the liquid phase than in the gaseous phase. For example, pure chlorine was liquified in a vessel cooled to —78 deg. C. and gaseous propylene supplied through a tube reaching to the bottom of the vessel. The propylene liquefied before mixing with the chlorine. When the theoretical quantity of propylene had been added, the product was found to consist of 80 to 85 per cent propylene dichloride with 15 to 20 per cent higher chlorinated derivatives. (1,315,542, 1,315,545 and 1,315,547; assigned to Union Carbide Co.; Sept. 9, 1919.)

Personal

Mr. JOHN H. ALLISON has joined the sales engineering department of the Celite Products Co., in the Pittsburgh district.

Dr. SERGIO BAGNARA is now consulting engineer and general manager of the Marine & Commerce Pocahontas Corp., Welch, W. Va.

Mr. H. A. BRAENDLE, formerly of the general laboratories of the Canadian Consolidated Rubber Co., has joined the rubber section of the Ames Holden McCready System, as physicist in charge of its Montreal laboratories.

Mr. C. E. CARSTENS of Anaconda, Mont., has accepted a position with the Andes Copper Mining Co., at Potrerillos, Chile.

Mr. O. A. P. CLARK of Murray Howe & Co., New York City, has resigned to accept a position as assistant operating chemical engineer with the Newport Co., of Milwaukee, Wis., at its Carrollville works.

Mr. WILLIAM M. CORSE has resigned as technical superintendent of the Ohio Brass Co. to accept a position as general manager of the Monel Metal Products Corp. of Bayonne, N. J.

Mr. ROBERT S. DAVIS has taken a position with Walker Bros. Consolidated Copper Co., at Portola, Calif.

Mr. ROSS H. DICKSON, formerly captain in the Ordnance Department, U. S. A., and engaged on the construction of toluol recovery plants during the war, before which he was with the Semet-Solvay Co., has just been released from the service and is now located with the Standard Oil Co. of New Jersey at the Bayway refinery, Elizabeth, N. J., as chemical engineer in the manufacturing development division.

Mr. WALTER DOBBINS, formerly with the Chino Copper Co. at Hurley, N. Mex., has gone to Chuquicamata, Chile, in the employ of the Chile Exploration Co.

Mr. D. K. FRENCH, who has served the Chicago section of the American Chemical Society as secretary and treasurer for nine years, on retiring from active participation in the work, was presented with a testimonial subscribed by the members as an appreciation of his long and faithful service.

Mr. WALTER H. GARASHA has severed his connection with the Deegan Supply Co., and associated himself with the Atlas Laboratory Equipment Bureau, Chicago, Ill.

Mr. LOUIS J. GUREVICH has resigned his position as assistant physicist in metallurgy with the Bureau of Standards and has accepted the position of metallurgist in the research department of the Hydraulic Pressed Steel Co. at Cleveland, Ohio.

Mr. F. D. HARGER has accepted the position of general manager and vice-president of the Mono Corporation of America, Buffalo, N. Y.

Mr. H. H. HARRIS has been appointed manager for the department of heat-treating equipment of the Quigley Furnace Specialties Co., New York. Mr. Harris was formerly general sales manager for the Swedish Crucible Steel Co.

Mr. W. W. HARTMAN has accepted employment with the Eastman Kodak Co. as research chemist on organic chemicals.

Mr. ELLWOOD HENDRICK, consulting editor of CHEMICAL & METALLURGICAL ENGINEERING, delivered a lecture under the auspices of the Pittsburgh chapter of Phi Lambda Upsilon at Carnegie Lyceum Hall on the evening of Dec. 3 on "Chemistry for Every Man." At noon of the same day Mr. Hendrick addressed the student body of the University of Pittsburgh.

Mr. J. D. JONES, recently with the Illinois Steel Co., is now general superintendent of the Algoma Steel Corp., at Sault Ste. Marie, Canada.

Mr. LOUIS J. KROM has resigned as managing editor of *Metal Industry* to accept a position as works manager with the new rolling mill of the West Virginia Metal Products Corp. He will continue on the staff of *Metal Industry* as rolling mill editor. Mr. ADOLPH BREGMAN is the new managing editor.

Mr. H. F. MCCONNELL has recently become superintendent in charge of the Louisville plant of the Tobacco By-products and Chemical Corporation.

Mr. L. H. NELSON has resigned his position as research chemist for the Goodrich Rubber Co. at Rock Island, Ill., and taken a position in the laboratory of the Standard Textile Products Co.

Mr. JAMES G. PARMELEE, recently research metallurgist with the School of Mines in co-operation with the U. S. Bureau of Mines, at Moscow, Idaho, is now connected with the Hardinge Conical Mill Co., Salt Lake City, Utah.

Mr. W. L. PENICK, until recently connected with the Salt Lake City office of the Hardinge Conical Mill Co., has been advanced to the position of Northwest sales manager, and will open a new branch office in Spokane, Wash.

Commander DONALD RILEY of the U. S. Naval Reserves has received the Order of the Crown from King Albert of Belgium for his service in that country as chemistry expert.

Mr. H. F. SCHIPPEL, formerly research engineer of the Canadian Consolidated Rubber Co., has joined the rubber section of the Ames Holden McCready System, as research engineer.

Mr. FRANK H. SMITH, until recently general manager of the East Helena plant of the American Smelting & Refining Co. and associated with the company since its organization, has accepted the position of assistant of the Bunker Hill & Sullivan Mining & Concentrating Co., at Kellogg, Idaho.

Mr. R. T. WALKER has resigned as superintendent of the Virginia Louise Mining Co. at Pioche, Nev., to become manager of the Ore Purchasing Department, United States Smelting, Refining & Mining Co., at Salt Lake City, Utah.

Dr. GERALD L. WENDT, of the University of Chicago, recently delivered a talk on "The Revelations of Radium," at the meeting of the Davenport Commercial Club.

Obituary

WILLIAM DIXON WEAVER, former editor of the *Electrical World*, died at his home in Charlottesville, Va., on Nov. 1, death coming apparently from heart failure while he slept. Mr. Weaver was born in Greensburg, Pa., Aug. 30, 1857, and after completing his studies at Kentucky University entered the United States Naval Academy, from which he was graduated in the class of 1880 as cadet engineer. The next twelve years were spent in the Navy. In 1893 Mr. Weaver was made editor of the *Electrical World*, then published by the W. J. Johnston Co. This journal was later purchased by Mr. McGraw and consolidated with the *American Electrician* and the *Electrical Engineer*. Mr. Weaver continued as editor until May, 1919. He was intensely interested in the organization of the electrical engineering profession and in the societies through which it was perfected. He served six years as manager of the American Institute of Electrical Engineers and was one of the founders of the Illuminating Engineering Society and the American Electrochemical Society.

Mr. E. C. MCKELVY, chief of the Physical Chemistry Section of the Chemistry Division of the Bureau of Standards, died of burns Nov. 29. The accident which resulted in his death occurred on Friday, Nov. 28, and the burns he sustained were at first considered not grave. Mr. McKelvy was active as secretary of the Washington Chemical Society and was a member of the American Chemical Society, the Washington Academy of Sciences, the American Association for the Advancement of Science and several other technical and scientific organizations.

Current Market Reports

The Non-Ferrous Metal Market

New York, December 22, 1919—Lead and tin have advanced, but copper remains at 28¼c. There has also been a general rise in the price of scrap metals.

	Cents per Lb.
Aluminum, 98 to 99 per cent	32.00–33.00
Antimony, wholesale lots	9.75
Nickel, ordinary	42.00
Nickel, electrolytic	45.00
Tin, Straits, spot	53.50
Lead, New York, spot	7.25
Lead, E. St. Louis, spot	7.00
Zinc, New York	8.57½
Zinc, E. St. Louis	8.22½
Silver (Cents per oz.)	1.34

FINISHED METAL PRODUCTS

	Warehouse Prices, Cents per Lb.
Copper sheets, hot rolled	28.50
Copper sheets, cold rolled (over 14 oz.)	30.50
Copper bottoms	37.00
Copper rods	29.50
High brass wire and sheets	25.50
High brass rods	24.50
Low brass wire and sheets	28.25
Low brass rods	28.25
Brazed brass tubing	37.25
Brazed bronze tubing	42.00
Seamless copper tubing	32.00
Seamless bronze tubing	36.00
Seamless brass tubing	30.50

SCRAP METALS

	Buying Prices
Aluminum castings	22.00–23.50
Aluminum sheets	21.00–22.50
Lead, heavy	5.60– 5.85
Lead, tea	4.38– 4.50
Zinc, scrap	4.50
Copper, heavy cut and crucible	15.50
Copper, heavy and wire	13.50
Copper, light and bottoms	12.50
Brass, heavy	8.00
Brass, light	6.15

The Iron and Steel Market

In the steel mills and departments that had been closed by coal shortage there has been a rapid resumption since the Indianapolis settlement of Wednesday, Dec. 10. The following Monday the majority of the closed departments opened, although it was only on that day that coal production on any large scale was beginning at the union mines. The quick resumption was due chiefly to the prompt release of coal which the railroads, under direction of the Fuel Administration, had been holding in reserve to be parceled out for the most essential uses. An estimate that seems fair is that of the total amount of consigned coal held by the railroads on Nov. 1, when the coal strike started, about one-third remained at the time of the Indianapolis settlement. Much of this coal lay near, but not in, the original consignee's works, and the release of the coal meant immediate delivery. The total curtailment in steel production due to coal shortage was an important item on the basis of a week's production, but a small item in comparison with a month's normal output, and an insignificant amount in a year's total.

BLAST-FURNACES DECREASE PRODUCTION

The blast-furnaces have not been having as easy a time as the steel mills. The by-product coke ovens have been

increasing their operations but are not yet running full and may not until after Christmas. As to the Connellsville region, its production of coke was to be restricted by 25 per cent according to the original order, but by 50 per cent according to the final order, this order being rescinded Saturday morning, Dec. 13. In the week ending on that day the actual coke production in the Connellsville and Lower Connellsville region, according to the report of the Connellsville *Courier*, was 191,600 tons, a decrease of 71,210 tons, or 27 per cent, from the output of the preceding week, when the output was larger than the November average, which was to be taken in figuring the decrease. This was a good showing from the blast-furnace standpoint, but in the week following the production has not materially increased and may indeed prove to have been a trifle less. The difficulty was in car supply. The week opened with 100 per cent car supply on Monday, this decreasing to 70 per cent the next day and to 40 per cent the day following, while for Saturday few if any cars were expected. The railroads do not seem to have been affected as much as in previous years by the first real cold snap of the season, but they were very busy with coal movement. The Monongahela Railroad in particular was practically congested with loaded coal. The blast-furnaces may not be in easy position in the matter of coke until the early part of January, particularly as the holidays always produce troubles of their own in the matter of coke production. Few furnaces have banked or will have to bank, but quite a number have slowed down. Moderately large stocks had been accumulated by many furnaces before the pinch came.

Pig Iron Advance Continues

The Philadelphia and Buffalo pig iron markets have gone up $1 a ton, and so has the Southern market. Prices at valley furnaces are up $1 on bessemer and $2 on basic, while foundry iron has now brought for second quarter the same price previously ruling for prompt and early deliveries only. The market on foundry iron now stands as follows: Philadelphia, $41.10; Buffalo, $40; Cleveland, $38.40; Chicago, $40; Birmingham, $35. The valley market stands at $36 for bessemer, $35 for basic and $38 for foundry, irrespective of delivery.

The pig iron markets have been showing signs of quieting down and precedents will be broken if the next fortnight, on account of the holidays, is not decidedly quiet. While some merchant furnacemen predict a continuation of the advance next year, it has been noted in past years that the market does not automatically resume, after a holiday dullness, where it left off, but requires a fresh impetus. With consumers apparently fairly well covered for the next few months, this impetus may not be furnished.

Steel Scarcity Spreads

Measured by the descriptions of steel for which premiums, or advances over the March 21 price schedule, can be secured, the steel scarcity has spread, since plates are now on the list. A month ago plates could be had on attractive orders at 2.50c., against the 2.65c. price in the March 21 schedule, but in the past few days lots of 1000 tons and over have gone at 2.75c. for delivery over a few weeks. The Steel Corporation's price, of course, remains at 2.65c., and indeed the corporation has made various tenders in the past few months to the Navy Department at 2.50c.

The wire nail situation is not relieved, the wire mills having particular difficulty in getting output from their nail departments. Some descriptions of spring wire are very scarce. Hot and cold rolled strip continue extremely scarce.

Throughout the steel industry much difficulty is experienced in getting tonnage results. There is both a shortage of men and a low level of morale and efficiency. The iron and steel strike is over, so far as there being any number of men still on strike, but some men have drifted into other employments. Even the Wheeling district, the last to hold out, is done with the strike. The two pipe mills in the district are already in partial operation, also the La Belle and Laughlin tin plate plants. The Yorkville plant has been operating for several weeks.

The Ferro-Alloy Market

The market during the past week has been flat, displaying nothing of particular interest in prices, demand or supply.

Ferrochrome, 6-8 per cent carbon contained, dropped from 23-24c. per lb. to 19-20c. per lb., while 4-6 carbon contained lowered to 21c. per lb., against 25c. of the previous week. There has been a brisk market on *molybdenite*, 85 per cent MoS_2, which is being quoted nominally at 75-85c. per lb., with very little available.

There is a moderately good demand for *ferromanganese*, and domestic makers have made several sales at their recently advanced price of $120, delivered. Reports are that offerings of English ferromanganese have appeared again, sales being made at $110, c.i.f., but with no quotations out now at that figure. *Spiegeleisen* is $38 to $40, f.o.b. furnace.

Electrolytic ferrosilicon has advanced lately and is now held at $90 for 50 per cent and at $140 to $150 for 75 per cent, delivered Pittsburgh, Cleveland, etc. Bessemer ferrosilicon is quoted as follows: 10 per cent, $59.50; 11 per cent $62.80; 12 per cent, $66.10, f.o.b. Jackson, Ohio.

The Chemical Market

New York, December 19, 1919.

The market of the past week compared with the previous report is easier; prices have remained firm but demand has fallen off slightly, which is partly due to the fact that inventories are being taken.

Sodium bichromate, which has been soaring lately and has been quoted as high as 45c. per lb., has had a turn, and with the present stock on hand the price has dropped to 19-25c. per lb. The low end of the *formaldehyde* quotation has dropped to 20c., which makes the present listing 20-37c. per lb., while *caustic soda* is scarce and has jumped from $3.80 per cwt. to $4.30. The hoarding of silver in India and China is one of the causes of the scarcity of that metal which in turn placed *silver nitrate* on a very unstable footing. The quotation at the present writing is 81⅝-82½c. per oz., but with the present fluctuation this price will probably change within the hour. There is no *denatured alcohol* available and the price has jumped from 72-78c. to 80c. per gal. on 188 proof and from 68 to 76c. per gal. on 190 proof.

The future of the *coal-tar* industry is especially bright and increased activity is expected in both foreign and domestic markets. Foreign inquiries have not been so heavy during the past week. *Dimethylaniline* is still in large demand and has come up to a high mark of 92c. per lb., as contrasted with 85c., the corresponding figure of last week. The present quotation on this item is from 60 to 92c. per lb. *Aniline salts* at present are active at 40-42c. per lb., against 37c. of last week, while *aniline oil* also advanced from 34-35c. per lb. to 35-36c. Very little *phenol* remains on the market, most of the output being already sold. A nominal quotation of 12¾-16c. per lb. still remains.

The *waxes* continue firm, with especial activity in the paraffine grades. Demand is still a step ahead of supply in these lines, but there has been no material change in prices. In the *flotation oils* demand is rather brisk, with the Government price of $1.25 per gal. still in effect on the pine oil steam dist. sp.gr. 0.930-0.940 and $1 on the pure dist.

There has been a slight falling off of foreign inquiry in *naval stores*, but prices remain the same. The low prices mentioned last week are holding in the Southern market, which tends to stabilize New York quotations.

In the *crude rubber* market up river fine dropped to 47½-48c. per lb., against 53-54c. per lb. of last week, while first latex went up to 52c. compared with 51½c. of the previous report. There has been very little activity in this line, rubber buyers seeming to have ample stocks.

Linseed oil has been under considerable inquiry and there has been a slight advance in price, raw car lots being quoted at $1.90 against $1.87 per gal. last week, and raw tank cars at $1.85 per gal., compared with $1.83 a week ago.

The Government prices of *coke* remain unaltered, foundry being listed at $6 and furnace at $7 per ton; the output of furnace coke has been greatly increased to meet the large demand.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	..... –	$0.60 – $0.65
Acetone	lb.	$0.20 –	.21 – .....
Acid, acetic, 28 per cent.	cwt.	2.50 – $2.75	3.00 – 3.25
Acetic, 56 per cent.	cwt.	5.00 – 5.50	6.00 – 6.50
Acetic, glacial, 99½ per cent, carboys	cwt.	13.00 – 13.50	13.50 – 15.50
Boric, crystals	lb.	.15 – .15½	.15½ – .16½
Boric, powder	lb.	.14½ – .15	.15 – .16
Hydrochloric, (muriatic) tech. 20 deg.	cwt.	..... –	2.25 – 2.50
Hydrofluoric, 52 deg.	lb.	.12 –	.14 – .....
Lactic, 44 per cent. tech.	lb.	.11 – .14	.12 – .16
Lactic, 22 per cent. tech.	lb.	.05 – .06	.05½ – .07
Molybdic, C. P.	lb.	..... –	4.00 – 4.25
Nitric, 40 deg.	lb.	.06 – .06½	.07 – .08½
Nitric, 42 deg.	lb.	.07 – .07½	.08 – .....
Oxalic, crystals	lb.	.30 – .31	.30 – .33
Phosphoric, Ortho, 50 per cent. solution	lb.	.09 –	.10 – .14
Picric	lb.	.30 – .35	.40 – .50
Pyrogallic, resublimed	lb.	..... –	2.30 – 2.60
Sulphuric, 60 deg., tank cars	ton	12.00 – 16.00	..... – .....
Sulphuric, 60 deg., drums	ton	17.00 –	22.00 – .....
Sulphuric, 60 deg., carboys	ton	20.00 –	25.00 – .....
Sulphuric, 66 deg., tank cars	ton	17.00 – 18.00	22.00 – 23.00
Sulphuric, 66 deg., drums	ton	20.00 – 21.00	25.00 – 26.00
Sulphuric, 66 deg., carboys	ton	25.00 –	30.00 – 40.00
Sulphuric, fuming, 20 per cent. (oleum) tank cars	ton	20.00 –	26.00 – .....
Sulphuric, fuming, 20 per cent. (oleum) drums	ton	25.00 –	32.00 – .....
Sulphuric, fuming, 20 per cent. (oleum) carboys	ton	30.00 –	35.00 – .....
Tannic, U. S. P.	lb.	..... –	1.35 – 1.45
Tannic (tech.)	lb.	..... –	.42 – .55
Tartaric, crystals	lb.	..... –	.69 – .74
Tungstic, per lb. of WO	lb.	..... –	1.20 – 1.40
*Alcohol, Ethyl	gal.	4.80 – 4.95	5.50 – .....
*Alcohol, Methyl	gal.	1.30 –	1.33 – 1.38
*Alcohol, denatured, 188 proof	gal.	..... –	.80 – .82
*Alcohol, denatured, 190 proof	gal.	..... –	.76 – .78
Alum, ammonia lump	lb.	.03½ – .04	.04½ – .04¾
Alum, potash lump	lb.	.08 – .08½	.09 – .09½
Alum, chrome lump	lb.	.15 – .16	.18 – .20
Aluminum sulphate, commercial	lb.	.01½ – .02	.02½ – .02½
Aluminum sulphate, iron free	lb.	.02½ – .03	.03½ – .03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.08½ –	.09½ – .10
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	..... –	.30 – .33
Ammonium carbonate, powder	lb.	.13 – .13½	.14 – .14½
Ammonium chloride, granular (white salammoniac)	lb.	.13½ – .14	.14½ – .15½
Ammonium chloride, granular (gray salammoniac)	lb.	.12 – .12½	.13 – .13½
Ammonium nitrate	lb.	.10 –	.11 – .12
Ammonium sulphate	lb.	.05 –	.06 – .....
Amyl acetate	gal.	..... –	3.65 – 3.75
Arsenic, oxide, lumps (white arsenic)	lb.	..... –	.09 – .09½
Arsenic, sulphide, powdered (red arsenic)	lb.	..... –	..... – .....
Barium chloride	ton	90.00 – 95.00	95.00 – 100.00
Barium dioxide (peroxide)	lb.	.22 –	.24 – .....
Barium nitrate	lb.	.09½ – .10½	.11 – .12
Barium sulphate (precip.) (blanc fixe)	lb.	.03 – .03½	.03½ – .04
Bleaching powder (see calcium hypochlorite)		..... –	..... – .....
Blue Vitriol (see copper sulphate)		..... –	..... – .....
Borax (see sodium borate)		..... –	..... – .....
Brimstone (see sulphur, roll)		..... –	..... – .....
Bromine	lb.	..... –	.65 – .75
Calcium acetate	cwt.	2.00 – 2.05	2.10 – .....
Calcium carbide	lb.	..... –	.04½ – .05
Calcium chloride, fused, lump	ton	19.00 – 25.00	30.00 – 40.00
Calcium chloride, granulated	lb.	.01½ – .01¾	.02 – .02½
Calcium hypochlorite (bleaching powder)	cwt.	..... –	2.75 – 3.75
Calcium peroxide	lb.	..... –	1.50 – 1.70
Calcium phosphate, monobasic	lb.	..... –	.02 – .03
Calcium sulphate, precipitated	lb.	..... –	.09 – .09½
Carbon bisulphide	lb.	.05½ –	.06 – .....
Carbon tetrachloride, drums	lb.	.10 – .11	.12 – .14
Carbonyl chloride (phosgene)	lb.	..... –	.75 – .....
Caustic potash (see potassium hydroxide)		..... –	..... – .....
Caustic soda (see sodium hydroxide)		..... –	..... – .....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.05 – .05½	.08 – .....
Cobalt oxide	lb.	..... –	1.50 – 1.55
Copperas (see iron sulphate)		..... –	..... – .....
Copper carbonate, green precipitate	lb.	..... –	.28 – .31
Copper cyanide	lb.	..... –	.65 – .70
Copper sulphate, crystals	lb.	.08½ – .08¾	.09 – .09½
Cream of tartar (see potassium bitartrate)		..... –	..... – .....
Epsom salt (see magnesium sulphate)		..... –	..... – .....
Formaldehyde, 40 per cent.	lb.	..... –	.20 – .37
Glauber's salt (see sodium sulphate)		..... –	..... – .....
Glycerine	lb.	..... –	.24½ – .26
Iodine, resublimed	lb.	..... –	4.50 – .....
Iron oxide, red	lb.	..... –	.03 – .20
Iron sulphate, (copperas)	cwt.	1.00 –	1.20 – 1.50
Lead acetate, normal	lb.	..... –	.15 – .16
Lead arsenate (paste)	lb.	..... –	.13 – .17
Lead nitrate, crystals	lb.	..... –	.85 – .86½
Litharge	lb.	..... –	.09½ – .10½
Lithium Carbonate	lb.	..... –	.50 – .....
Magnesium carbonate, technical	lb.	..... –	.13 – .14½
Magnesium sulphate, U. S. P.	100 lb.	2.00 – 2.63	2.75 – 3.00
Magnesium sulphate, commercial	100 lb.	1.75 –	2.00 – 2.50
Nickel salt, double	lb.	.14 –	.15 – .....
Nickel salt, single	lb.	.12 –	.15 – .16
Phosgene (see carbonyl chloride)		..... –	..... – .....
Phosphorus, red	lb.	..... –	.75 – .90
Phosphorus, yellow	lb.	..... –	.35 – .37
Potassium bichromate	lb.	.26 – .27	.30 – .35
Potassium bitartrate (cream of Tartar)	lb.	..... –	.58 – .60
Potassium bromide, granular	lb.	..... –	.50 – .65
Potassium carbonate, U. S. P.	lb.	.60 –	.65 – .70
Potassium carbonate, crude	lb.	.29 –	.30 – .....
Potassium chlorate, crystals	lb.	.30 – .20	.21 – .....
Potassium cyanide, 98-99 per cent.	lb.	nominal	
Potassium hydroxide (caustic potash)	lb.	.28 – .32	.35 – .40
Potassium iodide	lb.	..... –	3.55 – 3.60
Potassium nitrate	lb.	.19 –	.21 – .....
Potassium permanganate	lb.	..... –	.55 – .65
Potassium prussiate, red	lb.	..... –	1.05 – 1.15
Potassium prussiate, yellow	lb.	..... –	$0.36 – $0.40
Potassium sulphate	ton	225.00 –	..... – .....
Rochelle salts (see sodium potas. tartrate)		..... –	..... – .....
Salammoniac (see ammonium chloride)		..... –	..... – .....
Sal soda (see sodium carbonate)		..... –	..... – .....
Salt cake (sodium sulphate)	ton	17.00 – 21.00	..... – .....
Silver cyanide	oz.	..... –	1.25 – .....
Silver nitrate	oz.	..... –	.81½ – 82½
Soda ash, light	100 lb.	2.00 –	2.05 – .....
Soda ash, dense	100 lb.	2.25 – 2.35	2.50 – 2.75
Sodium acetate	lb.	.05½ – .06½	.07 – .08
Sodium bicarbonate	100 lb.	2.60 –	2.75 – 3.00
Sodium bichromate	lb.	..... –	.19 – .25
Sodium bisulphate (nitre cake)	ton	3.00 – 8.00	10.00 – .....
Sodium bisulphite	cwt.	1.80 – 1.90	2.00 – 2.10
Sodium borate (borax)	lb.	.08 – .09	.09 – .10
Sodium carbonate (sal soda)	100 lb.	1.35 – 1.50	1.50 – 1.75
Sodium chlorate	lb.	.15 –	.16 – .18½
Sodium cyanide, 96-98 per cent.	lb.	.30 –	.31 – .34
Sodium fluoride	lb.	.14 –	.15 – .16
Sodium hydroxide (caustic soda)	100 lb.	..... –	..... – 3.80
Sodium molybdate	lb.	2.50 –	3.25 – .....
Sodium nitrate	100 lb.	..... – 3.25	3.75 – 4.00
Sodium nitrite	lb.	.15 – .17	..... – .18
Sodium peroxide, powdered	lb.	..... –	.30 – .32
Sodium phosphate, dibasic	lb.	.03½ – .04	.04½ – .05
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.43 – .45½
Sodium prussiate, yellow	lb.	.23 – .24	.24 – .25
Sodium silicate, solution (40 deg.)	lb.	.01½ – .02	.02 – .02½
Sodium silicate, solution (60 deg.)	lb.	.02½ – .03	.03½ – .04½
Sodium sulphate, crystals (Glauber's salts)	cwt.	1.15 – 1.25	1.50 – 2.00
Sodium sulphide, crystal, 60-62 per cent. (cone)	lb.	..... –	.05 – .06
Sodium sulphite, crystals	lb.	.03½ –	.04 – .06
Strontium nitrate, crystals	lb.	.25 –	.28 – .....
Sulphur chloride	lb.	.05½ –	.06 – .....
Sulphur, crude	ton	22.00 –	..... – .....
Sulphur dioxide, liquid, cylinders	lb.	..... –	.10 – .12
Sulphur (sublimed), flour	100 lb.	3.10 –	3.40 – 3.65
Sulphur, roll (brimstone)	100 lb.	2.95 –	3.15 – 3.40
Tin bichloride (stannous)	lb.	.44 –	.46 – .50
Tin oxide	lb.	..... –	.60 – .....
Zinc carbonate, precipitate	lb.	..... –	.20 – .....
Zinc chloride, fused	lb.	.12½ –	.13½ – .14
Zinc cyanide	lb.	.49 –	.50 – .....
Zinc dust	lb.	.09 – .11	.11 – .14
Zinc oxide, dry American	lb.	..... –	.09½ – .12
Zinc sulphate	lb.	.03½ – .03¾	.04 – .04½

*Nominal quotations.

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.00 —	$1.10
Alpha naphthol, refined	lb.	1.40 —	1.50
Alpha naphthylamine	lb.	.32 —	.50
Aniline oil, drums extra	lb.	.35 —	.36
Aniline salts	lb.	.40 —	.42
Anthracine, 80% in drums (100 lb.)	lb.	.90 —	1.00
Benzaldehyde (f.f.c.)	lb.	1.00 —	1.15
Benzidine, base	lb.	1.10 —	.....
Benzidine, sulphate	lb.	.90 —	1.00
Benzoic acid, U. S. P.	lb.	.90 —	1.10
Benzoate of soda, U. S. P.	lb.	.80 —	1.00
Benzol, pure, water-white, in drums (100 lb.)	gal.	.27 —	.31
Benzol, 90%, in drums (100 lb.)	gal.	.25 —	.29
Benzyl chloride, 95-97%, refined	lb.	.35 —	.40
Benzyl chloride, tech	lb.	.25 —	.35
Beta naphthol benzoate	lb.	.50 —	.52
Beta naphthol, sublimed	lb.	.75 —	.80
Beta naphthol, tech.	lb.	.45 —	.55
Beta naphthylamine, sublimed	lb.	2.25 —	2.35
Cresol, U. S. P., in drums (100 lb.)	lb.	.18 —	.....
Ortho-cresol, in drums (100 lb.)	lb.	.23 —	.25
Cresylic acid, 97-99%, straw color, in drums	gal.	.80 —	.85
Cresylic acid, 95-97%, dark, in drums	gal.	.85 —	.90
Cresylic acid, 50%, first quality, drums	gal.	.60 —	.....
Dichlorbenzol	lb.	.07 —	.10
Diethylaniline	lb.	1.40 —	2.25
Dimethylaniline	lb.	.60 —	.92
Dinitrobenzol	lb.	.26 —	.37
Dinitroclorbenzol	lb.	.25 —	.30
Dinitronaphthaline	lb.	.45 —	.55
Dinitrophenol	lb.	.32 —	.36
Dinitrotoluol	lb.	.38 —	.45
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38 —	.65
Diphenylamine	lb.	.58 —	.75
H-acid	lb.	1.60 —	1.75
Metaphenylenediamine	lb.	1.15 —	1.80
Monochlorbenzol	lb.	.12 —	.15
Monoethylaniline	lb.	1.50 —	1.75
Naphthaline crushed, in bbls. (250 lb.)	lb.	.06 —	.08
Naphthaline, flake	lb.	.06½ —	.07½
Naphthaline, balls	lb.	.08½ —	.10
Naphthionic acid, crude	lb.	.75 —	1.25
Nitrobenzol	lb.	.14 —	.19
Nitro-naphthaline	lb.	.40 —	.45
Nitro-toluol	lb.	.27 —	.20
Ortho-amidophenol	lb.	3.00 —	4.25
Ortho-dichlor-benzol	lb.	.15 —	.20
Ortho-nitro-phenol	lb.	.90 —	1.25
Ortho-nitro-toluol	lb.	.25 —	.40
Ortho-toluidine	lb.	.25 —	.45
Para-amidophenol, base	lb.	2.50 —	3.50
Para-amidophenol, HCl	lb.	2.50 —	3.25
Para-diehlor-benzol	lb.	.15 —	.18
Paranitraniline	lb.	1.15 —	1.25
Para-nitro-toluol	lb.	1.35 —	1.50
Paraphenylenediamine	lb.	2.50 —	4.00
Paratoluidine	lb.	2.00 —	2.50
Phthalic anhydride	lb.	1.50 —	2.15
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12½ —	.16
Pyridin	gal.	2.00 —	2.50
Resorcin, technical	lb.	3.75 —	4.00
Resorcin, pure	lb.	6.50 —	6.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.45 —	.60
Salicylic acid, U. S. P.	lb.	.45 —	.50
Salol	lb.	.90 —	.95
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.22 —	.27
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.19 —	.24
Sulphanilic acid, crude	lb.	.25 —	.30

Tolidine	lb.	$1.70	—	$2.50
Toluidine, mixed	lb.	.45	—	.55
Toluol, in tank cars	gal.	.28	—	.....
Toluol, in drums	gal.	.32	—	.30
Xylidine, drums, 100 gal.	lb.	.44	—	.50
Xylol, pure, in drums	gal.	.37	—	.45
Xylol, pure, in tank cars	gal.	.35	—	.....
Xylol, commercial, in drums, 100 gal.	gal.	.37	—	.45
Xylol, commercial, in tank cars	gal.	.23	—	.27

Waxes

Prices based on original packages in large quantities.

Beeswax, natural crude, yellow	lb.	$0.42	—	$0 44
Beeswax, refined, yellow	lb.	47	—	.48
Beeswax, white pure	lb.	.63	—	.66
Carnauba, No. 1	lb.	.80	—	.83
Carnauba, No. 2, regular	lb.	.65	—	.78
Carnauba, No. 3, North Country	lb.	.44	—	.50
Japan	lb.	.18½	—	.20
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.06	—	.07
Paraffine waxes, crude, scale 124-126 m.p.	lb.	....	—	.06½
Paraffine waxes, refined, 118-120 m.p.	lb.	....	—	.09
Paraffine waxes, refined, 128-130 m.p.	lb	.09½	—	.10½
Paraffine waxes, refined, 133-135 m.p.	lb.	....	—	.12
Paraffine waxes, refined, 135-137 m.p.	lb.	....	—	.13
Stearic acid, single pressed	lb.	.23	—	.26
Stearic acid, double pressed	lb.	.28	—	.29
Stearic acid, triple pressed	lb.	.32	—	.33

NOTE—Quotations on paraffine waxes are nominal.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$1.25
Pine oil, pure, dest. dist.	gal.	1.00
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.47
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.65
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.38
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.00
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	....
Pinewood creosote, ref.	gal.	.51

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.	280 lb.	$17.00	—	$17.50
Rosin E-I	280 lb.	17.55	—	18.25
Rosin K-N	280 lb.	19.75	—	23.00
Rosin W. G.-W. W.	280 lb.	22.50	—	24.25
Wood rosin, bbl.	280 lb.	17.00	—	17.50
Spirits of turpentine	gal.	1.65	—	1.66
Wood turpentine, steam dist.	gal.	1.63	—	....
Wood turpentine, dest. dist.	gal.	1.50	—	....
Pine tar pitch, bbl.	200 lb.	8.25	—	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50	—	14.90
Retort tar, bbl.	280 lb.	15.00	—	15.25
Rosin oil, first run	gal.	.86	—	.91
Rosin oil, second run	gal.	.88	—	.93
Rosin oil, third run	gal.	.95	—	1.12
Rosin oil, fourth run	gal.	1.05	—	1.15

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.33½
70-72 deg., steel bbls. (85 lb.)	gal.	.31½
68-70 deg., steel bbls. (85 lb.)	gal.	.30½
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.23½

Crude Rubber

Para—Upriver fine	lb.	$0.53	—	$0.54
Upriver coarse	lb.	....	—	.35½
Upriver caucho ball	lb.	.34½	—	.35½
Plantation—First latex crepe	lb.	.51½	—	....
Ribbed smoked sheets	lb.	.51½	—	....
Brown crepe, thin, clean	lb.	.46½	—	.47½
Amber crepe No. 1	lb.	.49	—	....

Oils

VEGETABLE

Unless otherwise noted, the following prices are f.o.b., New York.

Castor oil, No. 3, in bbls.	lb.	$0.18½	—	$0.19
Castor oil, AA, in bbls.	lb.	.21½	—	.22
China wood oil, in bbls.	lb.	.22½	—	.23
Cocoanut oil, Ceylon grade, in bbls.	lb.	.17½	—	.18½
Cocoanut oil, Cochin grade, in bbls.	lb.	.19½	—	.20
Corn oil, crude, in bbls.	lb.	....	—	.21½
Cottonseed oil, crude (f.o.b. mill)	lb.	.18	—	.19
Cottonseed oil, summer yellow	lb.	....	—	.27
Cottonseed oil, winter yellow	lb.	....	—	.28
Linseed oil, raw, car lots	gal.	....	—	1.87
Linseed oil, raw, tank cars	gal.	....	—	1.83
Linseed oil, boiled, car lots	gal.	....	—	1.90
Olive oil, commercial	gal.	2.50	—	2.80
Palm, Lagos	lb.	.17	—	.17½
Palm, bright red	lb.	.16½	—	.17½
Palm, Niger	lb.	.16	—	.17½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.23½	—	.23½
Peanut oil, refined, in bbls.	lb.	.27	—	.28
Rapeseed oil, refined in bbls.	gal.	1.45	—	1.50
Rapeseed oil, blown, in bbls.	gal.	1.60	—	....
Soya bean oil (Manchurian), in bbls., N. Y.	lb.	.17½	—	.18½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.15½	—	.15½

FISH

Winter pressed Menhaden	gal.	$1.20	—	.....
Yellow bleached Menhaden	gal.	1.23	—	....
White bleached Menhaden	gal.	1.25	—	.....
Blown Menhaden	gal.	1.26	—	....

Miscellaneous Materials

All Prices f.o.b., N. Y.

Barytes, domestic, white, floated	ton	$35.00	—	$40.00
Barytes, off color	ton	20.00	—	25.00
Blanc fixe, dry	lb.	.03½	—	.04½
Blanc fixe, pulp	ton	30.00	—	50.00
Casein	lb.	.16	—	.18
Chalk, English, light	lb.	.05	—	.07
Chalk, English, light	lb	04½	—	.06
Chalk, English, dense	lb.	$ .04	—	$ .05
China clay (Kaolin), imported, lump	ton	25.00	—	35.00
China clay (Kaolin), imported, powdered	ton	30.00	—	60.00
China clay (Kaolin), domestic, lump	ton	10.00	—	20.00
China clay (Kaolin), domestic, powdered	ton	25.00	—	40.00
Feldspar	ton	13.50	—	17.00
Fluorspar, acid grade, lump, f.o.b. mines	net ton	30.00	—	35.00
Fluorspar, acid grade, ground, f.o.b. mines	net ton	35.00	—	45.00
Fuller's earth, domestic, powdered	ton	25.00	—	30.00
Fuller's earth, imported, powdered	ton	35.00	—	40.00
Pumice stone, imported	lb.	.03	—	.06
Pumice stone, domestic	lb.	.02½	—	.....
Shellac, TN	lb.	1.10	—	1.15
Shellac, D. C.	lb.	.....	—	....
Shellac, V. S. O.	lb.	.....	—	....
Shellac, Diamond I.	lb.	.....	—	....
Shellac, orange, fine	lb.	1.25	—	.....
Shellac, orange, superfine	lb.	1.20	—	1.30
Shellac, A.C. garnet	lb.	1.10	—	.....
Shellac, bleached, bone dry	lb.	1.35	—	.....
Shellac, bleached, fresh ground	lb.	1.10	—	1.15
Soapstone	ton	15.00	—	25.00
Talc, domestic	ton	16.00	—	60.00
Talc, imported	ton	60.00	—	70.00

Refractories

Following prices are f.o.b. works:

Chrome brick	net ton	80-90 at Chester, Penn.
Chrome cement	net ton	45-50 at Chester, Penn.
Clay brick, 1st quality fireclay	1,000	35-45 at Clearfield, Penn.
Clay brick, 2nd quality	1,000	30-35 at Clearfield, Penn.
Magnesite, dead burned	net ton	50-55 at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton	80-90 at Chester, Penn.
Silica brick	1,000	41-45 at Mt. Union, Penn.

Ferro-alloys

All prices f.o.b. works.

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00	—	$250.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon	lb.	.20	—	.40
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon	lb.	0.21	—	.50
Ferro-manganese, 70-80% Mn	gross ton	110.00	—	115.00
Spiegeleisen, 16-20% Mn	gross ton	33.00	—	41.00
Ferro-molybdenum, per lb. of Mo	lb.	3.00	—	3.50
Ferro-silicon, 50%	gross ton	85.00	—	95.00
Ferro-silicon, 75%	gross ton	150.00	—	175.00
Ferro-silicon, 10-15%	gross ton	45.00	—	60.00
Ferro-tungsten, 70-80%, per lb. of contained W.	lb.	1.25	—	1.40
Ferro-uranium, 35-50%, of U	lb.	7.00	—	.....
Ferro-vanadium, 30-40% per lb. of contained V.	lb.	5.50	—	7.00

Ores and Semi-finished Products

Chrome ore, 35-40%, Cr_2O_3	unit	$0.60	—	$0.80
Chrome ore, 48% and over	unit	1.00	—	1.25
*Coke, foundry, f.o.b. ovens	net ton	7.00	—	7.50
*Coke, furnace, f.o.b. ovens	net ton	6.00	—	6.50
Petroleum coke, refinery, Atlantic seaboard	net ton	12.00	—	12.50
Fluorspar, gravel, f.o.b. mines	net ton	.....	—	25.00
Manganese ore, 45% Mn and over	unit	.50	—	.75
Manganese ore, chemical (MnO_2)	gross ton	60.00	—	70.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	.75	—	.85
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	9.00	—	15.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	7.50	—	10.00
Uranium oxide, 96%	lb.	2.75	—	3.00
Vanadium pentoxide, 99%	lb.	6.00	—	.....
Pyrites, foreign, lump	unit	.17	—	.....
Pyrites, foreign, fine	unit	.17	—	.....
Pyrites, domestic, fine	unit	.16	—	.17½
Ilmenite, 52% TiO_2	lb.	.02	—	.....
Rutile, 95% TiO_2	lb.	.11	—	.....
Carnotite, minimum 2% U_3O_8, per lb. of U_3O_8	lb.	2.75	—	3.00
Zircon, washed, iron free	lb.	.10	—	.....
Monazite, per unit of ThO_2	unit	42.00	—	.....

* Government prices.

Plant Materials and Supplies

In carload lots, New York, unless otherwise stated.

BUILDING MATERIALS

Portland cement, at dock, without bags	bbl.	$2.80
Lump lime, common, including container	300 bbl.	2.65
Common brick, at dock	M.	16.00
Yellow pine, 3x4 to 8x8, 20 ft. and under	M.	48.00
Yellow pine, 3x4 to 8x8, 20 ft. and under at Chicago	M.	50.00
Yellow pine, 3x4 to 8x8, 20 ft. and under at St. Louis	M.	40.00
Roofings, tar felt (14 lb. per 100 sq.ft.)	ton	70.00
Roofings, tar pitch (in 400-lb. bbl.) carlots	ton	21.00
Roofings, asphalt pitch carlots	ton	34.00
Roofings, asphalt felt carlots	ton	63.00
Roofings, slate-surfaced, per roll of 108 sq.ft. carlots		2.25
Roofings, slate-finished shingles, 100 sq.ft. carlots		6.00
Linseed oil, raw in barrels	gal.	1.75
Linseed oil, 5 gal. cans	gal.	1.90
Red lead, dry, 100 lb. keg	lb.	.13
Red lead, in oil, 100 lb. keg	lb.	.14½
Red lead, dry, 5 lb. cans	lb.	.15
Red lead, in oil, 5 lb. cans	lb.	.16½
White lead, dry and in oil, 100 lb. keg	lb.	.13
White lead, dry and in oil, 25 and 50 lb. kegs	lb.	.13½
White lead, dry and in oil, 5 lb. cans	lb.	.15

STRUCTURAL STEEL, MILL, PITTSBURGH

Beams and channels, 3 to 15-in.	100 lb.	$2.45
Angles, 3 to 6-in., ¼-in. thick	100 lb.	2.45
Tees, 3-in. and larger	100 lb.	2.45
Plates	100 lb.	2.66
Rivets, structural, ½-in. and larger	100 lb.	4.20
Rivets, conehead for boilers, ½-in. and larger	100 lb.	4.30
Sheets, No. 28 black	100 lb.	4.35
Sheets, No. 10 blue annealed	100 lb.	3.55
Sheets, No. 28 galvanized	100 lb.	5.70

For painted corrugated sheets, add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gage; for galvanized corrugated sheets, add 15c., all gages.

INDUSTRIAL

Financial, Construction and Manufacturers' News

Construction and Operation

NOTE—These items were compiled as of Dec. 22, but appear in this issue due to the delay in publication due to the printers' strike.

California

LOS ANGELES—The Los Angeles Soap Co., 633 East 1st St., is having plans prepared for the construction of a 30 x 40 x 80 ft. distillery building, etc., in connection with its soap factory at 1st and Alameda Sts. Morgan, Walls & Morgan, 1124 Van Nuys Bldg., architects.

Connecticut

WATERBURY—The Scoville Manufacturing Co., 99 Mill St., will build a 1-story, 30 x 100-ft. paint shop and 1-story, 12 x 22-ft. addition to its sub-station on Silver St. Estimated cost, $28,000. Work will be done by day labor.

Illinois

JACKSONVILLE—The city clerk will receive bids in January for the construction of a 1,500,000-gal. capacity filtration plant. Estimated cost, $50,000. S. A. Greeley, 39 West Adams St., Chicago, engineer.

Louisiana

MONROE—The city voted $1,450,000 bonds, part of which will be used for improvements to the waterworks, including a 3,000,000-gal. capacity filtration plant.

Massachusetts

WESTFIELD—The Vitrified Wheel Co., Emery St., will soon award the contract for the construction of a 2-story, 42 x 85-ft. manufacturing plant. Estimated cost, $25,000.

Michigan

DETROIT—The Detroit Motor Castings Co., Beaufait St., has awarded the contract for the construction of a 1-story, 60 x 155-ft. brass foundry, to J. L. Hopkins, Sun Bldg. Estimated cost, $35,000. Noted Oct. 22.

LANSING—The Allyne-Ryan Foundry Co., Aetna Rd., Cleveland, has awarded the contract for the construction of a 1-story, 300 x 400-ft. gray iron foundry, to the Christman Construction Co., 302 Union Trust Bldg., South Bend, Ind. Estimated cost, $300,000.

Minnesota

COLERAINE—A. King, secretary of the Board of Education, will receive bids in March for the construction of a 2-story, 150 x 270-ft. high school in the Canistes District. A special laboratory and a science department will be installed in same. Estimated cost, $500,000. W. T. Bray, Torrey Bldg., Duluth, architect and engineer.

Montana

HARDIN—The city has awarded the contract for the construction of a water filtration plant, including a 2-story, 39 x 56-ft. building, a 30 x 44-ft. filter building with a capacity of 1,000,000 gal. per day, and a 32 x 56-ft. coagulating basin, to the Security Bridge Co., 502 West 32nd St., Billings. Estimated cost, $89,517.

New Jersey

NEW BRUNSWICK—The city plans to issue $13,000 bonds for the construction of additional units at the filtration plant.

New York

COLLEGE POINT—The American Hard Rubber Co. is having plans prepared for the construction of a 1-story, 120 x 130-ft. factory addition. Walter Kidde, 140 Cedar St., New York City, architect and engineer.

LONG ISLAND CITY—The G. M. Film Printing Co., Times Sq., New York City, has awarded the contract for the construction of a 2-story, 35 x 155-ft. film laboratory at Pierce and 8th Sts., to the Fleischman Construction Co., 531 7th Ave., New York City.

ROCHESTER—The city will build a large garbage and sewage disposal plant. Modern equipment will be installed in same.

ROCHESTER—The Josiah Anstice Co., Inc., plans to construct a 1-story, 145 x 216-ft. foundry building on Humboldt St. Estimated cost, $85,000.

SYRACUSE—The Mills Oil Co., 263 Walton St., plans to build 4 or 5 buildings, including an oil and gasoline building, on North Clinton St. Estimated cost, $200,000.

UTICA—Peter E. Hoffman, 2234 Whitesboro St., plans to construct a 1-story, 50 x 500-ft. factory building on Sunset Ave. Molding machines, equipped with individual motors to manufacture 5000 concrete building blocks daily, will be installed in same. Estimated cost between $40,000 and $45,000.

WATERTOWN—The Board of Water, Light & Power has engaged Hazen, Whipple & Fuller, architects, 30 East 42nd St., New York City, to prepare plans for a settling basin to be added to the present water filtration system. Estimated cost, between $60,000 and $80,000.

North Dakota

DUNSEITH—The Board of Control is having plans prepared for the installation of a water-softening plant in the State Tuberculosis Sanitarium here. Estimated cost, $5000.

MAYVILLE—The city plans an election soon to vote on $10,000 bond for the installation of a water-softening plant. A. Joudet, city engineer.

Ohio

CANTON—The Weber Dental Manufacturing Co., 400 Cherry Ave., plans to construct a factory addition. One part will be used as an addition to the brass and aluminum foundry and another to the plating and polishing department. Estimated cost, $50,000.

CHILLICOTHE—The Mead Paper & Pulp Co., is having plans prepared for the construction of two buildings; 152 paper machines will be installed in same. Estimated cost, $60,000.

CLEVELAND—The Aetna Steel Castings Co. has awarded the contract for the construction of a 1-story, 20 x 35-ft. addition to its foundry at 2284 Scranton Rd., to W. I. Thompson, 5103 Euclid Ave. Estimated cost, $5000.

CLEVELAND—The city will soon award the contract for the construction of twelve 8 x 50-ft. grit chambers, flow channels, etc., in connection with the Easterly Sewage Treatment Works, foot of East 140th St. G. Gascoigne, 618 City Hall, engineer.

CLEVELAND—The Parish-Pool Copper Co., care of Paul E. Cleveland, Guardian Bldg., has awarded the contract for the construction of a 1-story, 150 x 500-ft. smelting and refining building on Clinton Rd., to A. W. Kilbourne Co., 6532 Euclid Ave. Estimated cost, $300,000.

COLUMBUS—The Columbus Dental Co., 634 Wagner St., engaged Otto Darst, architect, Brunson Bldg., to prepare plans and submit estimates for the construction of a 2-story, 38 x 100-ft. addition to its factory and a 2-story, 35 x 60-ft. office building. Estimated cost, $40,000.

DAYTON—The Miami Brass Foundry Co., McDonough and Bacon Sts., plans to build a 3-story, 75 x 120-ft. factory on McDonough St. Estimated cost, $100,000.

Pennsylvania

WILKES-BARRE—The Wyoming Valley Homeopathic Hospital, Dana St., plans to build a 4-story, 40 x 50-ft. hospital and will be in the market for laboratory equipment. Estimated cost, $90,000.

Tennessee

MEMPHIS—The Sugar Products Co., 16 Exchange Pl., New York City, plans to construct a molasses storage building to house a 500,000-gal. tank, etc. Estimated cost, $50,000.

Texas

BRECKENRIDGE—The Texas Co., 17 Battery Pl., New York City, has awarded the contract for the construction of a compressor and absorption plant, to Westinghuse, Church, Kerr, Inc., 37 Wall St., New York City. Estimated cost, $150,000.

CORSICANA—The Corsicana Oil & Refining Co. plans to build an oil refinery here. Estimated cost, $300,000. W. M. Elliott, 1004 West 3rd Ave., engineer.

WEST DALLAS (Dallas P. O.)—The Monarch Petroleum Co. has purchased a 30-acre site here and plans to construct a 5000-bbl. refinery on same. Estimated cost, $500,000. J. R. Aiken, Western Indemnity Bldg., Dallas, president.

Wisconsin

FORT ATKINSON — The Creamery Package Manufacturing Co., Fort Atkinson Bldg., has awarded the contract for the construction of a 2-story, 40 x 90-ft. enameling plant, to the Raulf Co., Patton Bldg., Milwaukee. Estimated cost, $25,000.

KEWASKUM—The Kewaskum Aluminum Co. has awarded the contract for the construction of a 2-story, 50 x 180-ft. factory, to John L. Stanage, 144 Oneida St., Milwaukee. Noted Oct. 29 and Nov. 5.

MANITOWOC—The Aluminum Goods Manufacturing Co., 15th and Franklin Sts., has awarded the contract for the construction of a 1-story, 300 x 340-ft. rolling mill, to W. W. Oeflein, 86 Michigan St., Milwaukee. Estimated cost, $300,000.

MILWAUKEE—The Pfister-Vogel Leather Co., 443 Virginia St., has awarded the contract for the construction of a 1-story, 150 x 300-ft. tannery at 2nd Ave. and Virginia St., to the Dahlman Construction Co., Majestic Bldg. Estimated cost, $125,000.

WEST ALLIS—Arthur Schneider, State Sanitary Engineer, City Hall, has recommended the reconstruction of the west end sewage disposal plant. Estimated cost, $10,000.

WEST BEND—The West Bend Aluminum Co. has awarded the contract for the construction of a 4-story, 72 x 144 x 192-ft. L shaped factory, also a 1-story, 72 x 120-ft. building, to the Northern Construction Co., Colby-Abbot Bldg., Milwaukee. Estimated cost, $100,000. Noted Oct. 29 and Nov. 5.

Ontario

FERGUS—J. Alpaugh & Son have purchased a site and are preparing plans for the construction of a modern marble works on same. Estimated cost, $25,000.

TORONTO—Appleon & Chimpman, consulting engineers, 68 Wellington St., E., are in the market for filter presses, feed dryers, etc.

Quebec

MONTREAL—B. J. Coghlin and Co., Ltd., 2050 Ontario St., will soon award the contract for the construction of a 2-story, 40 x 108-ft. factory for the manufacture of oils and greases, on Ontario St. Estimated cost, $18,600.

MONTREAL—The Canada Sugar Refining Co., 300 Montmorency St., has awarded the contract for the construction of a 3-story, 20 x 53-ft. sugar factory on Montmorency St., to the Church-Ross Co., Ltd., 10 Cathcart St. Estimated cost, $17,000.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold a meeting in St. Louis from Dec. 26 to Jan. 1.

THE AMERICAN CERAMIC SOCIETY will hold its annual meeting in Philadelphia, Pa., Feb. 23-26.

THE AMERICAN CHEMICAL SOCIETY will hold its annual meeting April 13 to 16 inclusive, in St. Louis.

THE AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Boston, April 8, 9, and 10.

THE AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting in New York, Feb. 16-19.

THE AMERICAN PHYSICAL SOCIETY will hold a meeting in St. Louis from Dec. 26 to Jan. 1.

THE NATIONAL FOREIGN TRADE CONVENTION will be held in San Francisco, May 12 to 15.

THE MINING AND METALLURGICAL SOCIETY OF AMERICA will hold a meeting in New York Jan. 13.